Method to Determine Optimal Riparian Buffer Widths for Atlantic Salmon Habitat Protection

Prepared for:

MAINE STATE PLANNING OFFICE

Augusta, Maine

Prepared By:

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with assistance from

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1.0 INTRODUCTION

The Maine Atlantic Salmon Task Force developed the Atlantic Salmon Conservation Plan (Plan) with the objective of ensuring the protection and recovery the Atlantic salmon (Salmo salar) runs associated with seven coastal rivers. The task force was comprised of citizens from a cross-section of public and private conservation and economic interests with a stake in how Atlantic salmon conservation and restoration will be practiced in affected Maine rivers. The affected rivers include the Dennys, East Machias, Machias, Pleasant, Narraguagus, Ducktrap and Sheepscot.

The Plan includes a number of conservation initiatives designed to address biological as well as physical components of restoration. It identifies habitat protection as an important component of these initiatives because widespread habitat degradation can potentially contribute to decreased production of salmon smolts from inland waters if particular habitat criteria for each resident life stage (egg, alevin, fry and parr) cannot be met. Habitat can be affected by parameters such as water quality, water quantity and surrounding land use. Predominant land uses of central and northern coastal Maine, where the targeted watersheds lie, include the growth and harvest of forest products and blueberries and cranberries. Effective buffers which minimize erosion and sedimentation, water quality contamination, stream warming, or alterations to surface water flow have been generally identified as important tools in minimizing adverse impacts.

The purpose of the Method to Determine Optimal Riparian Buffer Widths for Atlantic Salmon Habitat Protection is to:

(A) protect critical Atlantic salmon habitat from potential land use impacts along key segments of Atlantic salmon rivers in Maine by identifying optimal riparian buffer widths for this purpose, and

(B) provide a scientifically-based riparian conservation method that can be readily applied by groups such as watershed council volunteers, biologists, landowners, and conservation groups.

Appropriate buffer widths were determined by reviewing scientific literature that describes the relationship between buffer characteristics and buffer effectiveness. The method provides a means for identifying the size of the riparian buffer area that should be targeted during implementation of the Conservation Plan. For purposes of this method, "riparian buffer" is defined as a naturally vegetated terrestrial area bordering streams and rivers. Importantly, the Method can be applied to salmonid habitat conservation initiatives on rivers and streams in northern New England outside the seven targeted rivers if desired (*i.e.* the method takes into consideration conditions specific to the targeted region of downeast Maine, but is not river-specific). The method identifies buffer widths necessary to preserve key protective features of the riparian landscape, which in turn will protect the viability of the critical salmon habitats identified by the Maine Atlantic Salmon Authority and the U.S. Fish and Wildlife Service.

2.0 OVERVIEW

The method to determine optimal recommended buffer width is based on field and desk-top measurement of the most important attributes affecting buffer functions important for Atlantic salmon habitat conservation. The method is designed to be flexible in that it recognizes that there is variability in the amount and type of data (input variables) that will be able to be collected for different sites.

Buffer zones protect critical habitat by regulating temperature (shading), regulating streamflow (attenuating peak flow and maintaining base flows), protecting water quality, and providing organic input for salmon habitat and for a food base for aquatic macroinvertebrates. The following three primary and eight secondary attributes influence buffer effectiveness, and therefore the width of riparian buffer needed to protect critical in-stream habitat (Appendix C, Science-Base for Method, contains a more detailed description of these attributes):

Primary Attributes:

- Slope
- Soil type (as measured by soil hydrologic group)
- Vegetative cover (as measured by the degree of canopy closure)

Secondary Attributes:

- Surface roughness (ground vegetation, coarse woody debris, microtopography and forest floor)
- Surface water features (small streams and ponds within the buffer)
- Groundwater seepage/springs
- Sand and gravel aquifers
- Floodplains
- Wetlands
- Very steep slopes (*i.e.*, >25%)
- Stream order

The greater the number of buffer attributes that can be accurately determined, the more refined will be the determination of optimal width. In most cases all or most of the attributes will be able to be determined. However, even if certain buffer attributes cannot be determined (for example if field work is not practical or key map resources are not available for the area being evaluated) optimal width can still be approximated (see Section 3.3).

Appendix A contains the Project Data Form used to record both desk-top data from resources such as aerial photographs, U.S. Geological Survey (USGS) Topographic Maps, Soil Surveys, National Wetland Inventory (NWI) maps, and Significant Sand and Gravel Aquifer maps, as well as data collected in the field. Attachments A through F in Appendix A provide guidelines and information to be used in completing the data form. The buffer width key (see Attachment A, Appendix A) identifies unadjusted optimal buffer widths as a function of slope, soil hydrologic group, and percent canopy closure – all variables that can be readily determined using desk-top resources to the extent that soil survey data and aerial photos are available for the specific area being evaluated.

Secondary buffer attributes determine specific upward or downward adjustments to the numbers generated by the buffer width key. Floodplains and open (non-forested) wetlands, where present immediately adjacent to salmon streams, determine the baseline for buffer width measurement. Buffer width measurement begins at the landward edge of these features when present, or at the normal high water mark of the stream if these features are not present.

Field investigations generate important buffer attribute data (*e.g.* microtopography, ground vegetation, groundwater seepage/springs, land use, small streams, etc.) that may not be readily identifiable using desk-top resources alone. In addition to the collection of new data, field investigations should also be used to confirm or modify desk-top data as necessary. For example, if the percent canopy closure estimate is based on aerials that are several years old, the actual conditions may be found to be different in the field and the data should be adjusted accordingly.

Optimal buffer widths are divided into two zones. Zone 1, closest to the stream, is a no-disturbance (no-harvest) zone that should remain intact. Primary functions of Zone 1 are to provide optimal shading and temperature regulation, and to provide optimal rates of organic debris inputs. Additional functions include streambank stabilization and provision of a final barrier to potential water quality degradation. Zone 1 is a fixed-width of 35’ in which no disturbance to the soils or vegetation should occur.

Zone 2 is of variable width and extends from 35’ to the landward edge of the calculated optimal buffer width. For example, if the calculated optimal buffer width is 200’, Zone 2 would be 165’ wide. The primary functions of Zone 2 are to provide sediment filtering and other water quality functions and to maintain wind firm conditions within the riparian buffer to protect Zone 1 from higher than natural rates of wind-throw. Additional functions of Zone 2 include attenuation of peak stream flows and maintenance of base flows. Only land uses that do not compromise the desired functioning of Zone 2 should occur in this zone. As will be detailed later, such uses are limited to activities such as light tree harvesting and light recreational use. Figures 1-3 located at the end of Section 3.7, show the locations of the two zones relative to the stream resource being protected. The science-base for specific widths, specific buffer functions, and zonation of buffers are discussed in more detail in Appendix C entitled “Science-Base for Method”.

3.0 BUFFER EVALUATION PROCEDURE

3.1 Buffer Evaluator

The persons conducting the riparian buffer evaluation should be trained/supported by qualified professionals in the field of terrestrial ecology (including ecologists, botanists, wetland scientists, soil scientists, foresters, forest hydrologists and geologists). In general, desk-top components of the evaluation can be completed by a non-scientist, but field evaluation components would require either a professional or an evaluator trained by a professional.

3.2 Procedure

The method should follow these steps.

1. Identify the stream reach to be protected and the adjacent buffer evaluation area on resource maps including, but not limited to:
    a. aerial photographs
    b. Soil Survey
    c. National Wetland Inventory
    d. U.S.G.S. Topographic
    e. Significant Sand and Gravel Aquifer
    f. Surficial Geology

2. Divide buffer evaluation area into discrete buffer units for evaluation (see Section 3.5).

3. Determine the baseline for buffer measurement by identifying all floodplains and open (*i.e.* emergent and scrub-shrub) wetlands immediately adjacent to the stream or, if these features are not present, the normal high water mark of the stream (see Section 3.5).

4. Gather buffer attribute data using data sheets for each buffer unit. Data collection consists of both desk-top and field determinations (see Section 3.6).

5. Determine the unadjusted optimal buffer width for each buffer unit using the key. Slope, soil hydrologic group, and percent canopy closure determine the unadjusted buffer width (see Section 3.3).

6. Adjust the number generated from the key according to additional factors affecting buffer function (see Section 3.4). This consists of two sub-steps:

   - First, adjust buffer widths from the key for factors that result in specific increases or decreases to the optimal buffer width (*i.e.* surface water features, groundwater seepage/springs, degree of surface roughness, significant sand and gravel aquifers, and wetlands).

   - Second, in places where wetlands connected to the stream by surface hydrology, and/or very steep slopes extend beyond the calculated optimal buffer width, expand the optimal buffer width to include them (see Figure 1).

7. Map a continuous optimal buffer width line over the entire riparian buffer area (all buffer units) under evaluation. Do this by plotting data points representing optimal buffer width for each buffer unit as well as the shared lines between buffer units, and connecting them as shown in Figure 2. Extend the optimal buffer width line upstream beyond the critical in-stream habitat being protected for a distance equal to the width of the upstream-most buffer unit in an arc, as shown in Figure 2.

3.3 Buffer Width Key

The three buffer attributes utilized in the buffer width key (see Appendix A, Attachment A) are:

- Slope;
- Soil hydrologic group, and;
- Percent canopy closure.

The buffer width key is structured much like a plant key. The key generates an "unadjusted" buffer width that is subsequently adjusted up or down depending on additional important buffer attributes (secondary attributes are discussed in Section 3.4). The unadjusted recommended buffer widths range from a low of 70' for buffers with gentle slopes (0-8%), soils with a high infiltration capacity (hydrologic group A or B soils), and closed or nearly closed canopy forest cover, to a high of 230' for buffers with very steep slopes (>25%), low infiltration capacity (hydrologic group D soils), and an open canopy. Slope is weighted most heavily, followed by soil hydrologic group, and percent canopy closure, based on their relative influence on buffer effectiveness as indicated in the literature.

Ideally, all three variables should be determined. However, the model is designed to be flexible and can be used if only one or two of the three variables are known. If the only information known, for example, is that slopes are 8-15%, the unadjusted recommended buffer width would be 135' which is the average width for the 8-15% slope portion of the key. As a second example, if slopes are 0-8% and the hydrologic group is C, but percent canopy cover is not known, the recommended unadjusted buffer width would be 105'.

3.4 Adjustment Factors (Secondary Buffer Attributes not in Buffer Width Key)

The table below lists additional buffer attributes not included in the optimal buffer width key and specifies buffer adjustments for each of these variables.

Buffer Attribute	Adjustment to Buffer Width
Surface water features (*e.g.* streams, ditches, gullies, ponds)	If surface water features, whether perennial or intermittent, are present in the buffer and are connected to the in-stream habitat being protected by surface drainage, increase the buffer width by 50’.
Groundwater seepage/ springs (includes discharge of spring water, not seepage of perched or shallow groundwater runoff)	If groundwater seepage or springs are present in the buffer that are directly connected to the underlying aquifer (*i.e.* not perched), increase the buffer width by 25’.
Surface roughness (as function of the amount of microtopographic complexity, coarse woody debris, herbaceous vegetation, and the presence or absence of an intact duff layer)	If there is a high degree of surface roughness, decrease the optimal buffer width by 25’. If there is a low degree of surface roughness, increase the optimal buffer width by 25’. Do not adjust the optimal buffer width for moderate or typical levels of surface roughness.
Sand and gravel aquifers	If significant sand and gravel aquifers are present in the buffer, increase the buffer width by 25’.
Floodplains	Floodplains, no matter how wide, are considered part of the stream resource being protected rather than part of the buffer zone. Therefore, establish the baseline (start point) for buffer width measurement at the landward edge of floodplains (and also non-forested wetlands as detailed below).
Wetlands	If wetlands or portions of wetlands occur in the buffer, increase the buffer width by 25’ regardless of whether the wetland is isolated or connected. In addition, if wetlands or portions of wetlands occur in the buffer that are hydrologically connected to the in-stream resource being protected by surface (including seasonal or intermittent) drainage, expand the buffer as necessary to encompass the entire area of wetlands. Open wetlands (emergent and scrub/shrub wetlands) immediately adjacent to the stream are considered part of the stream resource being protected rather than part of the

Buffer Attribute	Adjustment to Buffer Width
	buffer zone. Therefore, establish the baseline (start point) for buffer width measurement at the landward edge of adjacent open wetlands.
Very steep slopes (*i.e.* > 25%)	If very steep slopes occur in the buffer, expand the buffer as necessary to encompass the entire area of very steep slopes.
Stream order	Buffers adjacent to first and second order streams no matter how narrow are afforded the same calculated optimal riparian buffer widths as larger streams (*i.e.* there is no downward adjustment for narrower, smaller order streams).

The range of potential "adjusted" buffer widths is from 70' to more than 300'. The minimum should never be below 70', since anything less could jeopardize wind firm conditions adjacent to the stream. For example, even if the key yields a recommended buffer width of 80' and a credit of 25' is determined as a result of a high degree of surface roughness as measured in the field, the adjusted recommended buffer width would be 70', not 55'.

3.5 Determination of Baseline and Buffer Unit Locations

- The normal high water mark of the stream serves as the baseline (start point) for measuring riparian buffer widths where floodplains and open (non-forested) wetlands are not present immediately adjacent to the stream. Where there are floodplains and/or open (non-forested) riparian wetlands immediately adjacent to the stream channel, the baseline or start point for measuring riparian buffer widths and buffer characteristics is the landward edge of these features (see Figure 1). Open wetlands include emergent and scrub-shrub wetlands.

  Rationale: Forested wetlands serve to provide riparian buffer functions such as shading, coarse woody debris inputs, and water quality renovation. Open-canopy wetlands at the stream margin are not able to optimally perform these functions. Such wetlands are generally ponded for much of the growing season and are closely linked to the stream by surface waters and functionally can be considered to be part of the stream itself. Floodplains accommodate potential future river meanders and are also closely linked by surface hydrology to the stream during flood periods.

- In order to determine the width of the riparian buffer to gather attribute data for, start by determining slope in the area between 0-100', and proceed as necessary through the table presented in Appendix A, Attachment B. At the start of the evaluation, the optimal buffer width is not yet known. Since slope is the most important readily-measurable buffer attribute affecting buffer function, this is a good way to get a quick initial approximation of the ultimate outcome as an indication of how far landward to measure buffer attributes. The optimal buffer width generated may not be identical to the width of buffer being measured but should be similar.

- The length of buffer units, as measured parallel to the baseline, depends on the size of the parcel being evaluated and possibly other factors (*e.g.* land ownership/permission to enter the property, location and size of critical in-stream salmon habitat areas). As a general rule of thumb, divide buffer evaluation areas into units that are no more than 300' along the stream (see Figure 2). Smaller buffer unit lengths result in a more refined determination of optimal buffer width. If the area of interest is 3,000' along the stream, at least 10 buffer units should be evaluated. The last buffer unit will be <300' long unless the length of evaluation area along the stream is exactly divisible by 300. Buffer evaluators should not feel constrained by the 300' increments, but should use this as a maximum. In situations of high landscape variability, evaluators should divide buffer units at natural break points such as abrupt changes in slope, soil type, vegetative cover, or sharp bend in the river.

- Measure buffer widths perpendicularly to the baseline (or if floodplains or open wetlands are not present, measure perpendicular to the stream axis) and on a horizontal plane. Also, establish the lines separating buffer units perpendicularly to the baseline.

3.6 Measurement of Buffer Attributes

3.6.1 Primary Attributes

Slope

Objective: Determine average slope for each buffer unit.
Data Source: Map resources (Soil surveys, USGS) or field measurement

The easiest way to determine slope is to use Soil Surveys and/or USGS maps. The slope classes chosen for the buffer width key were specifically chosen to coincide as much as possible with soils mapping units used in U.S.D.A County Soil Surveys. In most cases, a buffer unit will consist of a single soil unit. If there are one or more soil units, the slopes should be averaged according to the approximate percent of the buffer unit occupied by each soil type. Soil surveys are not yet available for some portions of the targeted salmon streams (*i.e.* portions of Washington County in unorganized townships). Alternatively slope can be calculated using USGS maps or can be measured in the field. Since USGS maps use 20' contours, only the steeper slopes may be able to be accurately determined. One technique of approximating slopes from USGS maps is to draw in 10' contour intervals exactly half-way between each 20' contour interval. Finally slope can be measured in the field using standard surveying equipment or a clinometer (preferably with % slope as well as degrees). Use of digitized (scanned) soils maps and other resource maps can be used in conjunction with GIS if these tools are available to the evaluator, however these graphical display and analysis tools are not required.

Soil Hydrologic Group

Objective: Determine soil hydrologic group for each buffer unit.
Data Source: Map resources (Soil Surveys, Surficial Geology) or field determination.

Soil hydrologic group is best determined using soil surveys. There is a hydrologic group (A through D) designated for each soil series. These designations are provided in Appendix A, Attachment E. For soil series where the hydrologic group is assigned as a combination (*e.g*. C/D), the more restrictive group (*i.e.* D) should be used. As with slope if more than one soil type occupies the buffer unit, the different hydrologic groups can be averaged to approximate average hydrologic group for the entire buffer unit. For example, if approximately ½ of a buffer unit is hydrologic group B and ½ is hydrologic group D, the average would be C. If 1/5 is C and 4/5 is D, C would be used. Impervious surfaces such as roads, houses and parking areas should be counted as hydrologic group D. For those areas where soil surveys are not available, a soil scientist can make soil hydrologic group determinations in the field.

As a final alternative, the "Surficial Geologic Map of Maine" (Maine Department of Conservation) can be used to approximate hydrologic class. For example, the following areas can be inferred to have hydrologic classes of D: 1. Bedrock, and; 2. Swamp, marsh and bog deposits. Hydrologic group C soils are likely to occur in the following areas: 1. Thin drift; 2. Fine-grained glacio-marine deposits, and; 3. Compact glacial till. Evaluators are provided with a list that links surficial deposit type with hydrologic group (Appendix A, Attachment F). Using surficial geology to estimate soil hydrologic group is less accurate than the use of soil surveys or field determinations since surficial geology maps are at a very coarse scale and should only be used as a last resort.

Percent Canopy Cover

Objective: Determine average percent canopy coverage for each buffer unit.
Data Source: Map resources (aerial photos) or field measurement.

Percent canopy cover can be estimated with the following desk-top method:

a. Acquire recent (no more than five years old) aerial photos with a scale no smaller than 1:24000 and preferably larger which show the buffer units of interest as close as possible to the photo center. Leaf-on photography is preferable for inexperienced interpreters.

b. Experienced interpreters can directly estimate canopy closure as 0%-25%, 25%-50%, 50%-75%, or 75%-100% with good accuracy. In borderline situations, these interpreters can use the following methodology, which is suggested for inexperienced interpreters.

- Overlay a 100 dot per square inch grid on each buffer unit, aligning randomly. Systematically visit each point on the dot grid, and tally whether it lies on top of a tree canopy or not. Move grid, again aligning randomly. Repeat count. Move grid, again aligning randomly. Repeat count. Sum the number of points from the three counts that intercepted the canopy, and divide this by the sum total of all points from the three counts to calculate the percent canopy cover. (*i.e.,* First count yielded 4 dots on trees and 0 on bare ground. Second count yielded 3 dots on trees and 2 on bare ground. Third count yielded 3 dots on trees and 1 on bare ground. 4 + 3 + 3 = 10. 4 + 5 + 4 = 13. 10/13 = 0.769 = 77%.) A 100 dot per square inch acetate template is attached to the inside-back cover of this method. Each line intersection (cross point) is considered a dot. This method works the same regardless of the scale of the aerial.

  Note: On 1:15840 photography, 198' is 0.15 inches. On 1:24000 photography, 200' is 0.10 inches.

Alternatively, percent canopy cover can be estimated with the following desk-top method:

For all properties, the landowner should be asked whether there has been harvesting or natural damage in the buffer areas since the photography was captured. If so, or if the photography is more than five years old, a field visit is recommended. On a field visit, canopy closure may be estimated by best professional judgement if it clearly falls into one of the four categories. Alternatively, percent canopy cover can be determined at five foot intervals along representative transect(s). At each point simply look straight up (use a densiometer or clinometer) and determine whether there is overhead canopy. Record observations and divide the number of points with canopy cover by the total number of points on the transect to estimate percent canopy closure (or, if a densiometer is used, follow the standard instructions).

3.6.2 Secondary Attributes

Floodplains

Objective: Determine the location of floodplains, if any, adjacent to the stream reach being evaluated.

Data Source: Map resources (Soil surveys) and/or field measurement

For areas where soil survey data is available, identification of floodplains is as straightforward as identifying those soil series that are derived from recent alluvial deposits. For example in Washington County the floodplain soils include: 1. Gouldsboro silt loam; 2. Medomak and Wonsqueak soils, frequently flooded, and; 3. Wonsqueak and Bucksport soils, frequently flooded. Additional soil series found in Maine that have been identified by the National Cooperative Survey as floodplain soils are: Alluvial, Charles, Cornish, Fryeburg, Hadley, Limerick, Lovewell, Medomak, Ondawa, Podunk, Rumney, Saco, Suncook, Sunday, and Winooski. (See Appendix A, Attachment E for Maine alluvial soil designations).

For those areas where soil surveys are not available, field work by a professional or trained buffer evaluator may be the only other way to determine the extent of floodplains. A reliable determination cannot be made using NWI maps, USGS maps, or Federal Emergency Management Agency (FEMA) floodplain maps. Field indicators of floodplains include drift lines, sediment deposits, water marks on trees shrubs or rocks, soils derived from alluvial sediments, and floodplain vegetation (*e.g.* black and green ash, silver maple, bog rosemary and other wetland ericads, false nettle, jewelweed, and ostrich fern).

Wetlands

Objective: Determine the location and type of wetlands both within the buffer and immediately adjacent to the stream reach being evaluated.

Data Source: Map resources (NWI, Soil surveys, USGS) or field measurement

Wetlands are identified using NWI maps, which are available for all portions of the state with occurrences of critical salmon habitat. NWI maps should also be used to determine if a wetland is forested or open (*i.e.* emergent or scrub-shrub). Most of the NWI maps for downeast sections of Maine are relatively recent (produced during the 1990's) and the accuracy of these maps is typically more than sufficient for the application of this method. Field evaluators may at times, however, find that existing wetland types or locations have changed relative to NWI maps (*e.g.* succession has resulted in a change from scrub-shrub to forested) or that wetlands are present that are not identified on NWI maps. In the case that a field assessment of wetlands differs from NWI maps, field work by a professional should always take precedence over NWI maps. Wetlands that are hydrologically connected by surface drainage (including intermittent or seasonal drainage) to the in-stream habitat under protection should be differentiated from isolated wetlands.

Surface Water Features

Objective: Determine the location and type (*e.g.* perennial stream, intermittent stream, pond) of surface water features within the buffer.

Data Source: Map resources (USGS, NWI, Soil Surveys, aerial photos) and field determination

Identify surface water features using NWI maps, recent aerials, Soil Surveys, and USGS maps as desk-top resources, as well as in the field if possible. Anything that would be considered a stream under Chapter 310 of the State of Maine NRPA regulations should also be considered a surface water feature for purposes of this method. In addition, ditches and swales (*e.g.* for stormwater management) are also included since such features are potential conduits for water quality contamination. Anything that appears on USGS maps as a solid or broken line whether perennial or intermittent should be included. Many but not all streams that meet the state definition are indicated on USGS maps, so field work should also be used to indicate un-mapped surface water features if possible. (See definition of river, stream or brook in glossary).

Groundwater Seepage or Springs

Objective: Determine if groundwater discharge as springs or seeps is present within the buffer.

Data Source: Field determination

This feature can only be accurately determined with a field visit. Only those situations where the underlying aquifer clearly intercepts the land surface should be counted. Perched wetlands and seeps from shallow subsurface runoff not having direct connection to the underlying aquifer, such as often occurs on compact tills (*e.g.* drumlins), should not be counted. A field indicator of springs is consistent discharge of cool water to the surface. The temperature of groundwater varies little through the seasons and is typically within a few degrees of mean annual air temperature (spring water feels cool in summer). Groundwater temperatures in Maine typically range from 4.4° C to 10.0° C (Weddle et al, 1988). Springs often occur on the side-slopes of river valleys and it is common for small spring-fed brooks, rivulets or seepage wetlands to emerge immediately below them. In Washington County, springs can emerge from the steep sides of course-textured glacial deposits such as outwash plains and eskers (Maine Natural Heritage Program, 1991). Sand and gravel aquifer maps, surficial geology maps and soils maps may be helpful but it is not possible for evaluators to definitively identify springs using these resources alone.

Surface Roughness

Objective: Determine the degree of surface roughness for each buffer unit.
Data Source: Field determination only.

Use Appendix A, Attachment C (Surface Roughness Guidelines) for this determination. The degree of surface roughness is related to the amount of microtopographic complexity, the condition of the duff layer (surface organic horizon), and the amount of coarse woody debris and herbaceous vegetation. Forested buffers with undulating or pit-and-mound topography, dense, low vegetation, a high degree of dead-and-down wood (or other features such as mossy boulders), and an intact duff layer have a high degree of surface roughness. Buffers with a low degree of surface roughness lack these features. High degrees of surface roughness are limited to complex forested systems lacking exposed mineral soils, and roads or other slowly permeable or impermeable land use features.

This feature requires field work to determine. Although the cutoffs are somewhat arbitrary, the guidelines in Appendix A, Attachment C specify surface roughness categories that leave little room for interpretation, can be easily replicated, and reflect conditions found in downeast Maine.

Note exposed mineral soils if present as an indication of erosion potential or land uses which have resulted in removal in places of the organic soil horizon. If exposed mineral soils have resulted from tip-ups (toppled trees where the root crown has ripped out of the earth exposing mineral soil horizons), or other natural phenomena, then the organic horizon can be considered intact.

Sand and Gravel Aquifers

Objective: Determine if significant sand and gravel aquifers are present within the buffer.

Data Source: Map resources (Sand and Gravel Aquifer, Surficial Geologic, Soil Surveys)

Significant sand and gravel aquifers are located on “Significant Sand and Gravel Aquifer” maps published by the Maine Department of Conservation (DOC). These maps alone are typically sufficient to identify significant sand and gravel aquifers and are available for virtually the entire region. If this is not the case, however, significant sand and gravel aquifers in the downeast Maine areas targeted in this method are located in highly permeable glacial deposits. Such deposits typically contain water tables near the surface in valley bottoms such as the riparian areas of larger streams. Such deposits are mapped by the “Surficial Geologic Map of Maine”, published by the Maine DOC. This map resource can be used to identify areas of highly permeable/coarse-textured surficial deposits such as glacial outwash and ice-contact glaciofluvial deposits (*e.g.*, eskers and kames). Additionally, Appendix A, Attachment E identifies soil series associated with sand and gravel aquifers.

Stream Order

Objective: Determine the stream order (optional).

Data Source: Map resources (USGS topographic)

Stream order is determined using USGS maps. Although stream order does not affect the optimal buffer width, this information may be useful with respect to prioritizing the acquisition and/or protection of critical riparian buffer habitats. For example, buffers on smaller order streams may be targeted for protection before buffers on larger order streams due to the fact that they may be more sensitive to land use impacts (Davies and Sowles, revised 1997).

3.7 Land Use Specifications for Zone 1 and Zone 2

Zone 1 is a no-disturbance or no-harvest zone where no land uses that involve disturbance to soils or vegetation should take place. Many of the intended Zone 1 functions such as shading and woody debris inputs will not operate optimally if tree removal or other land uses occur in this area.

There are low-impact uses that can take place in Zone 2 that do not compromise the desired functions of this zone as noted below. No uses that result in impervious surfaces, removal of the organic soil horizon, fertilization or chemical use, significant alterations to the infiltration capacity of the soils, or tree removal sufficient to jeopardize wind-firm conditions should occur in this variable-width zone. Uses that would compromise the desired functions of Zone 2 include but are not necessarily limited to residential and commercial development, septic disposal systems, roads, and agriculture (including blueberry and cranberry production but not including controlled tree harvesting as noted below).

Low-impact tree harvesting is one practice that may occur in this zone without compromising the desired functions. Literature indicates that controlled removal in this zone serves as a mechanism to remove stored nutrients and chemical pollutants sequestered in the boles and large branches of trees and enhances vigorous new growth through opening up the canopy (Welsch, 1991; Chase et al, 1997). Literature also indicates that controlled tree removal can take place without significantly affecting the infiltration capacity of the soils. However, there is also abundant literature to suggest that forestry operations can result in significant sedimentation and other impacts if not properly controlled (Davies and Sowles, revised 1997), and this precipitates the need for the limitations placed on forestry operations in Zone 2 that are outlined below.

The objectives for forestry operations in Zone 2 are as follows:

- To establish and maintain wind-firm, well-distributed, uneven-aged or multi-aged forest stands, and
- To maintain and protect soils and promote optimal riparian buffer function.

Therefore,

- Water Quality Best Management Practices (BMPs) should be observed at all times.
- New roads and borrow pits should not be developed in buffer areas.
- In all forest operations in Zone 2 buffer areas, the following stocking levels for trees ≥six inches in diameter at breast height (DBH) should be treated as an absolute minimum for residual stands:

  - In softwood stands (>66% softwood volume), 80 square feet per acre;
  - In mixed wood stands (34%-66% softwood volume), 70 square feet per acre;
  - In hardwood stands (<34% softwood volume), 50 square feet per acre.

- Furthermore, no more than 40% of the volume over six inches in DBH should be removed in any 10 year period from Zone 2 buffer areas.
- A 35' no-harvest strip should be maintained adjacent to all perennial surface water features (*i.e.* perennial streams, ponds) in Zone 2 that are directly connected by surface flow to the in-stream resource being protected.
- All harvesting operations in Zone 2 buffer areas should be planned prior to snow cover, in order to assure proper protection of all water resources in the buffer. Skid trails should be laid out to minimize potential soil disturbance in buffer areas. During operations, logging slash should be used to minimize soil disturbance where possible as per forestry BMP's.
- Harvesting operations in Zone 2 buffers should be curtailed when harvesting equipment creates significant soil disturbance (*e.g.*, mineral soils are exposed or sheet and rill erosion is evidenced). Operations should be limited to periods when the soils are frozen solid.
- If significant soil disturbance should occur, remediation should be undertaken immediately, with logging slash and other appropriate materials. Remediation should accomplish restoring conditions to the point where they are functionally similar to the pre-disturbance condition.

If these guidelines are followed, forest harvesting operations will not negatively affect buffer function and will not cause harm to in-stream habitats downslope or downstream.

Other land uses that would not compromise intended Zone 2 functions include light recreation (*e.g.*, walking trails, picnic tables, and low-impact camp sites).

Land uses affect buffer attributes such as percent canopy cover, surface roughness, and soil hydrologic group (infiltration capacity). These, in turn, affect optimal buffer width. Therefore, buffers that contain agricultural uses or development will, all else being equal, cause wider optimal buffer width determinations. But additional buffer width adjustments are not made as a result of specific land use practices historically occurring in the buffer. There are recommended land use restrictions in each buffer zone (zone 1 and zone 2), however in many cases it is impractical to eliminate historical uses, such as residential development or berry or crop production already in these zones. To the extent that such uses can be discontinued and the non-conforming portions of the buffer allowed to revert to naturally vegetated buffer, buffer effectiveness will be maximized. As succession allows abandoned lands to revert to forested systems, the calculated optimal buffer width will decrease (*i.e.*, due to greater percent canopy coverage, higher degrees of surface roughness, etc.).

Where it is not practical to remove/abandon prior uses, best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer. It is beyond the scope of this method to review buffer best management practices in detail. Where possible, however, the establishment of native woody vegetation (by planting or natural succession) within managed portions of the buffer is recommended. In addition, channelization of runoff should be prevented/minimized and adherence to stormwater best management practices is recommended.

Note: References are located in Appendix C (Science-Base for Method).

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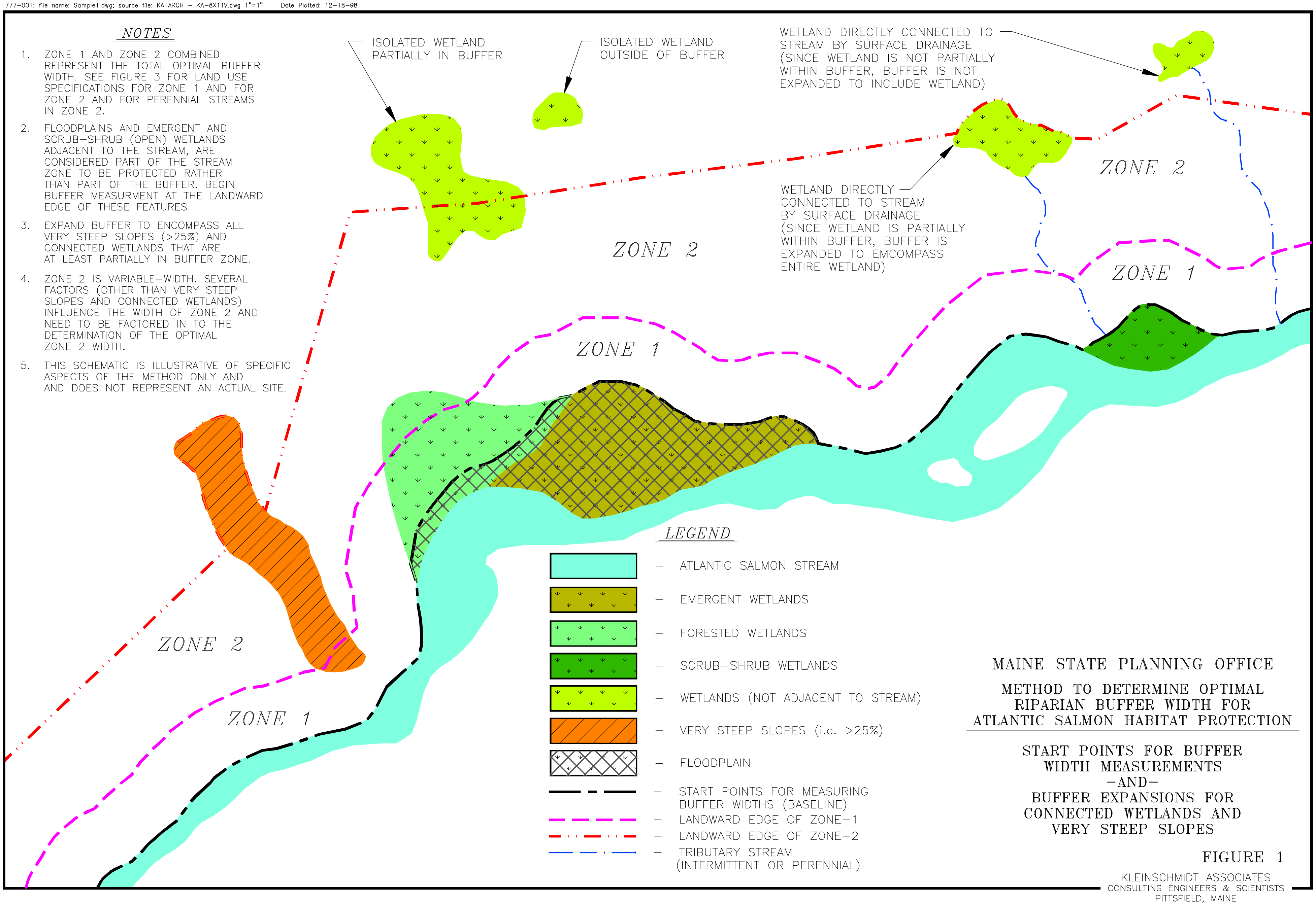
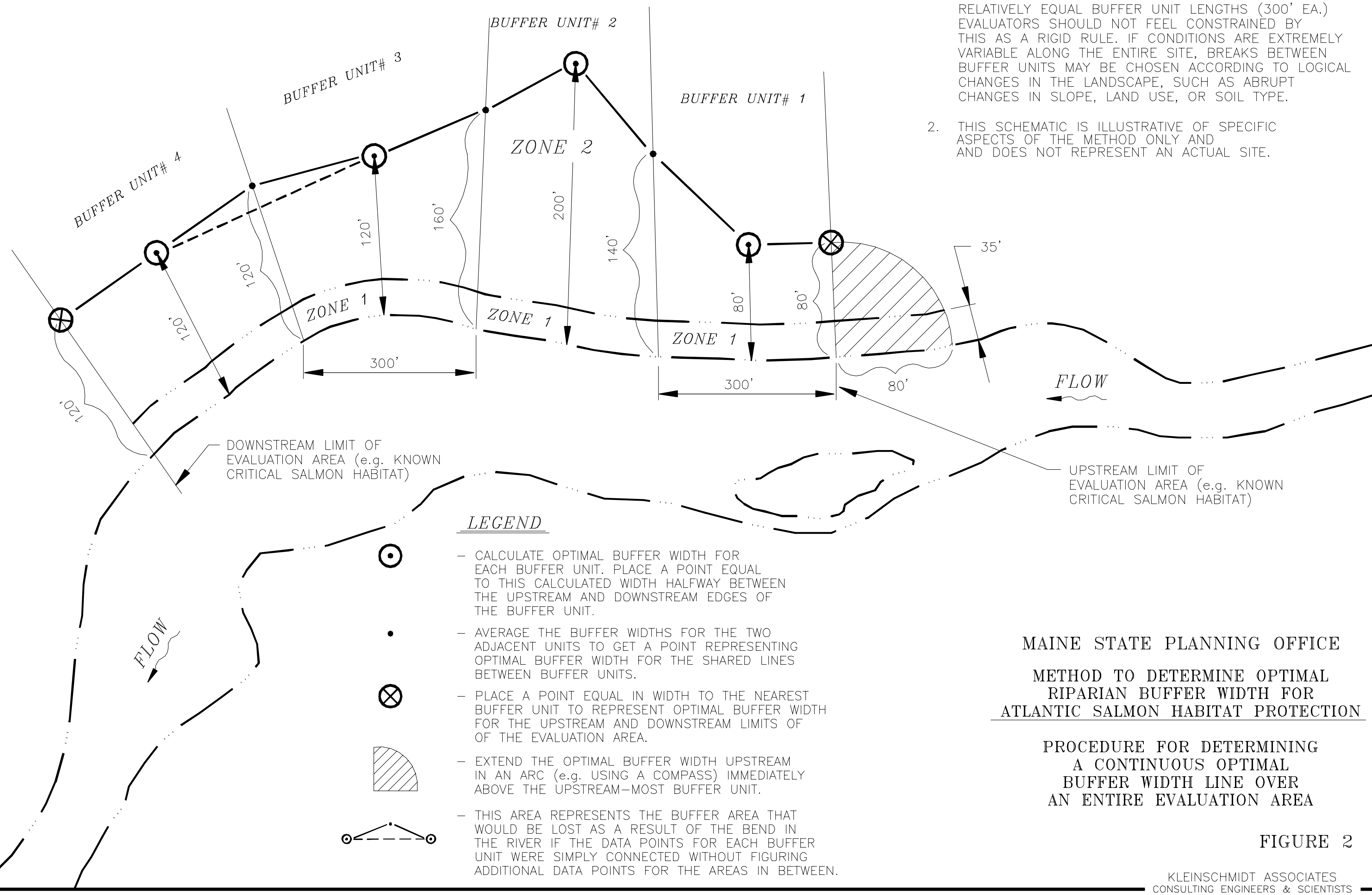


777-001; file name: Sample2.dwg; source file: KA ARCH – KA-8X11V.dwg 1"=1"   Date Plotted: 12-18-98

NOTES

1. BUFFER UNITS CAN HAVE VARIABLE LENGTHS ALONG THE RIVER, BUT SHOULD NOT EXCEED 300' PER UNIT. ALTHOUGH THE EXAMPLE IN THIS FIGURE USES RELATIVELY EQUAL BUFFER UNIT LENGTHS (300' EA.) EVALUATORS SHOULD NOT FEEL CONSTRAINED BY THIS AS A RIGID RULE. IF CONDITIONS ARE EXTREMELY VARIABLE ALONG THE ENTIRE SITE, BREAKS BETWEEN BUFFER UNITS MAY BE CHOSEN ACCORDING TO LOGICAL CHANGES IN THE LANDSCAPE, SUCH AS ABRUPT CHANGES IN SLOPE, LAND USE, OR SOIL TYPE.

2. THIS SCHEMATIC IS ILLUSTRATIVE OF SPECIFIC ASPECTS OF THE METHOD ONLY AND AND DOES NOT REPRESENT AN ACTUAL SITE.



LEGEND

– CALCULATE OPTIMAL BUFFER WIDTH FOR EACH BUFFER UNIT. PLACE A POINT EQUAL TO THIS CALCULATED WIDTH HALFWAY BETWEEN THE UPSTREAM AND DOWNSTREAM EDGES OF THE BUFFER UNIT.

– AVERAGE THE BUFFER WIDTHS FOR THE TWO ADJACENT UNITS TO GET A POINT REPRESENTING OPTIMAL BUFFER WIDTH FOR THE SHARED LINES BETWEEN BUFFER UNITS.

– PLACE A POINT EQUAL IN WIDTH TO THE NEAREST BUFFER UNIT TO REPRESENT OPTIMAL BUFFER WIDTH FOR THE UPSTREAM AND DOWNSTREAM LIMITS OF OF THE EVALUATION AREA.

– EXTEND THE OPTIMAL BUFFER WIDTH UPSTREAM IN AN ARC (e.g. USING A COMPASS) IMMEDIATELY ABOVE THE UPSTREAM-MOST BUFFER UNIT.

– THIS AREA REPRESENTS THE BUFFER AREA THAT WOULD BE LOST AS A RESULT OF THE BEND IN THE RIVER IF THE DATA POINTS FOR EACH BUFFER UNIT WERE SIMPLY CONNECTED WITHOUT FIGURING ADDITIONAL DATA POINTS FOR THE AREAS IN BETWEEN.

MAINE STATE PLANNING OFFICE

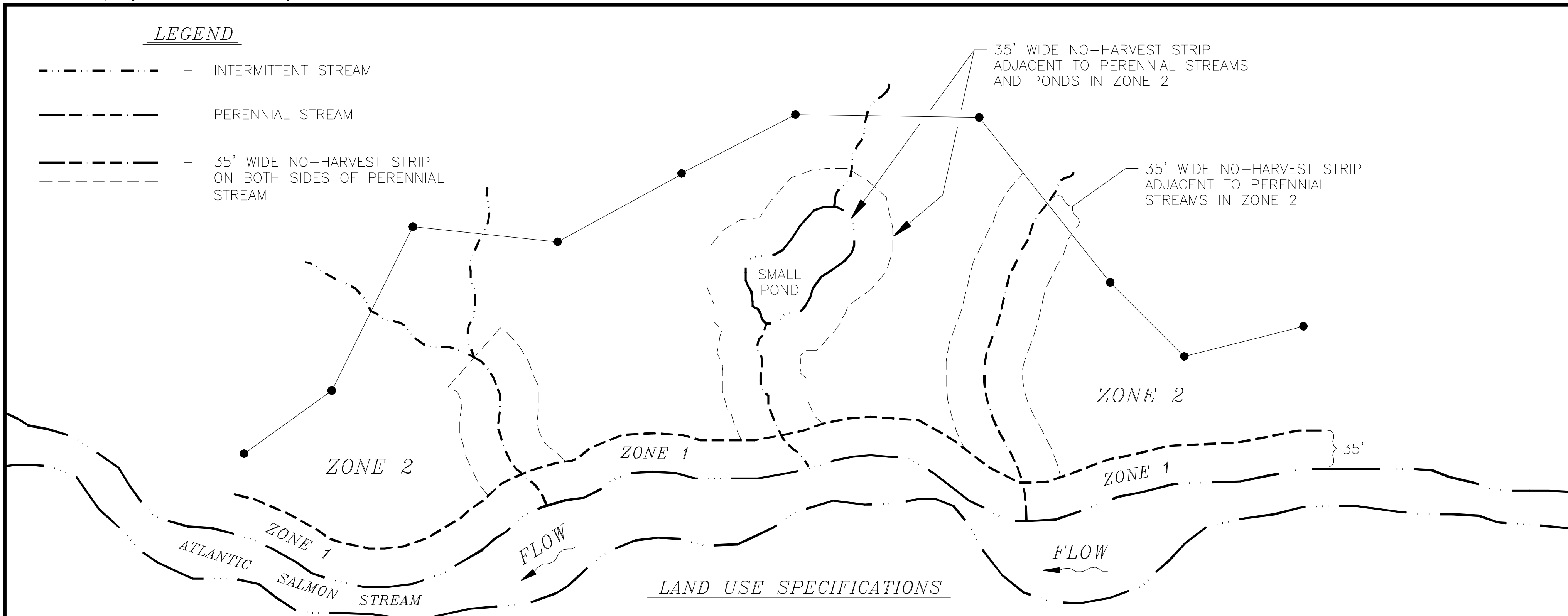
METHOD TO DETERMINE OPTIMAL RIPARIAN BUFFER WIDTH FOR ATLANTIC SALMON HABITAT PROTECTION

PROCEDURE FOR DETERMINING A CONTINUOUS OPTIMAL BUFFER WIDTH LINE OVER AN ENTIRE EVALUATION AREA

FIGURE 2

KLEINSCHMIDT ASSOCIATES
CONSULTING ENGINEERS & SCIENTISTS
PITTSFIELD, MAINE

777-001; file name: Sample2.dwg; source file: KA ARCH – KA-8X11V.dwg 1"=1" Date Plotted: 12-18-98



LAND USE SPECIFICATIONS

ZONE 1 – NO-DISTURBANCE/NO-HARVEST. NO LAND USES THAT INVOLVE DISTURBANCES TO SOILS OR VEGETATION SHOULD OCCUR IN THIS FIXED-WIDTH ZONE.

ZONE 2 – LIMITED USE. NO USES THAT INVOLVE IMPERVIOUS SURFACES, REMOVAL OF THE ORGANIC SOIL HORIZON, FERTILIZATION OR CHEMICAL USE, SIGNIFICANT ALTERATIONS TO THE INFILTRATION CAPACITY OF THE SOILS OR TREE REMOVAL SUFFICIENT TO JEOPARDIZE WIND-FIRM CONDITIONS SHOULD OCCUR. LIMITED, LOW IMPACT TREE HARVESTING IS ONE USE THAT MAY OCCUR IN THIS ZONE WITHOUT COMPRIMISING DESIRED ZONE 2 FUNCTIONS. FOR EXAMPLE, NO MORE THAN 40% OF THE VOLUME OVER 6" IN DBH SHOULD BE REMOVED FROM ZONE 2 BUFFER AREAS IN ANY TEN YEAR PERIOD AND OPERATIONS SHOULD BE LIMITED TO TIMES WHEN THE SOILS ARE FROZEN SOLID (SEE COMPLETE LIST OF ZONE 2 FORESTRY SPECIFICATIONS BEFORE CONDUCTING TIMBER REMOVAL IN THIS ZONE). WALKING TRAILS PICNIC TABLES AND LOW IMPACT CAMPING AREAS ARE OTHER POTENTIAL USES.

NOTES:

1. THIS SCHEMATIC IS ILLUSTRATIVE OF SPECIFIC ASPECTS OF THE METHOD ONLY AND AND DOES NOT REPRESENT AN ACTUAL SITE.

IMPORTANT: A 35' NO-HARVEST STRIP SHOULD BE MAINTAINED ADJACENT TO PERENNIAL STREAMS AND OTHER PERENNIAL SURFACE WATER FEATURES (e.g. PONDS) IN ZONE 2. THE LAND USE SPECIFICATIONS FOR THE 35' NO-HARVEST STRIPS ARE THE SAME AS DETAILED FOR ZONE 1.

MAINE STATE PLANNING OFFICE

METHOD OF DETERMINE OPTIMAL RIPARIAN BUFFER WIDTH FOR ATLANTIC SALMON HABITAT PROTECTION

LAND USE SPECIFICATIONS FOR ZONE 1 AND ZONE 2

FIGURE 3

KLEINSCHMIDT ASSOCIATES
CONSULTING ENGINEERS & SCIENTISTS
PITTSFIELD, MAINE

Glossary

Alluvium: material (such as gravel, sand, and silt) deposited on land by streams.
Areal cover: a measure of dominance that defines the degree to which above-ground portions of plants or other features cover the ground surface. It is possible for the total areal cover in a plant community to exceed 100 percent because (a) most plant communities consist of two or more vegetative strata; (b) areal cover is estimated by vegetative layer; and (c) foliage within a single layer may overlap.
Atlantic salmon habitat: as used here, critical Atlantic salmon habitat refers to areas of known spawning and rearing habitat as determined by field surveys on Atlantic salmon rivers conducted by the USFWS and the Atlantic Salmon Authority. These surveys involve(d) the delineation of discrete habitat units based on one or more physical characteristics that separated them from adjacent habitat types. As used more generally, Atlantic salmon habitat refers to the sum total of environmental characteristics required for the life of this species.
Basal area: the cross-sectional area of a log or tree measured at breast height (about 4.5 ft).
Baseflow: the portion of stream flow that is not due to storm runoff, but is supported by groundwater seepage into a channel.
Baseline: the line or start point from which buffer widths are measured perpendicularly. This line coincides with the normal high water mark of the stream where there are no open (non-forested) wetlands or floodplains immediately adjacent to the stream. Where open wetlands or floodplains occur adjacent to the stream, the baseline coincides with the landward edge of these features.
Best management practices (BMP's): methods, measures, or practices designed to prevent or reduce water pollution.
Boulders: rock fragments larger than 2 feet (60 centimeters) in diameter.
Buffer attribute: biotic (*e.g.* vegetation) or abiotic (*e.g.* slope, soils, hydrology) characteristics associated with a particular buffer unit or buffer area.
Buffer unit: as used here, a discrete portion of a larger riparian buffer area in which buffer attributes are measured and an optimal buffer width is determined. Typically, evaluation areas are broken-down into multiple buffer units that should not exceed 300' in length as measured along the river/stream. Breaks between buffer units may be chosen according to logical changes in the landscape, such as abrupt changes in slope, land use, or soil type.
Buffer zone: an administratively defined area established along a stream or other environmentally sensitive feature to provide protection for aquatic resources from land-use activities or, the zone contiguous with a sensitive area required for the continued maintenance, function, and structural stability of the sensitive area. The critical functions of a riparian buffer for the protection of Atlantic Salmon Habitat include shading, retention and uptake of nutrients, stabilization of banks, interception of sediments, accommodation of overflow during high water events, maintenance of baseflow/attenuation of peak flow, protection from disturbance by humans and domestic animals, provision of coarse woody debris and other organic inputs, and provision of room for movement of aquatic system boundaries over time due to hydrogeologic changes.
Canopy layer: the uppermost layer of vegetation in a plant community. In forested areas, mature trees comprise the canopy layer. A completely closed canopy intercepts direct sunlight. An open canopy allows direct sunlight to reach the herbaceous stratum, forest floor and waters within a riparian buffer zone.

Clinometer: a hand-held instrument used to measure slope or angle, allowing for field determination of tree height, slope, etc.
Coarse textured soil: sand or loamy sand. In Maine, coarse-textured soils are usually derived from sand and gravel deposited by glacial processes or recent alluvial processes.
Critical habitat: see Atlantic salmon habitat.
Densiometer: a hand-held instrument used to estimate percent canopy coverage.
Detritus: minute fragments of dead and decaying plant parts found on the soil surface. When fused together by algae or soil particles, this is an indicator that surface water was recently present.
Diameter at breast height (DBH): the width of a plant stem as measured at 4.5 ft above the ground surface.
Dominance: a descriptor of vegetation that is related to the standing crop of a species in an area, usually measured by height, areal cover, or basal area (for trees).
Dominant species: a plant species that exerts a controlling influence on or defines the character of a community.
Drift line: an accumulation of debris along a contour (parallel to the water flow) that represents the height of an inundation event.
Drumlin: a low, smooth elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.
Duff: see organic horizon.
Emergent plant: a rooted herbaceous plant species that has parts extending above a water surface.
Erosion: the wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep, detachment and movement of soil or rock fragments by water, wind, ice, or gravity.
Esker: a narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.
Flooded: a condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks, runoff from adjacent or surrounding slopes, inflow from high tides, or any combination of sources.
Floodplain: areas that are inundated with flood water based on site specific information including the presence of alluvial soils.
Foodplain forest: temporarily flooded forested wetlands found along major rivers and streams. They are often dominated by silver maple, green ash, and American elm. Ostrich fern is usually the characteristic herb along with sensitive fern, jewelweed, and false nettle.
Forested wetland: freshwater wetlands dominated by woody vegetation that is 6 meters (20 feet) or taller.
Freshwater wetland: freshwater swamps, marshes, bogs and similar areas that are inundated or saturated by surface or groundwater at a frequency and for a duration sufficient to support, and which under normal circumstances do support, a prevalence of wetland vegetation typically adapted for life in saturated soils and not part of a great pond, coastal wetland, river, stream or brook.
Glacial outwash: gravel, sand, and silt, commonly stratified, deposited by glacial melt water.
Glacial till: unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.
Glaciofluvial deposits: material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits: material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.
Habitat: the specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all of the basic requirements for life. Also see Atlantic Salmon Habitat.
Herb: a nonwoody individual of a macrophytic species. Also may include seedlings of woody plants (including vines) that are less than 3.2 ft in height.
Herbaceous layer: any vegetative stratum of a plant community that is composed predominantly of herbs.
Hydric soil: a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (U.S. Department of Agriculture-Soil Conservation Service, 1985). Hydric soils that occur in areas having positive indicators of hydrophytic vegetation and wetland hydrology are wetland soils.
Hydrologic regime: the sum total of water that occurs in an area on average during a given period.
Hydrologic soil groups: refers to soil grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.
Hydrology: the science dealing with the properties, distribution, and circulation of water.
Impervious area: impermeable surfaces, such as pavement or rooftops, which prevent the infiltration of water into the soil.
Infiltration rate: the rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.
Intermittent stream: a stream that carries water only part of the year. Sometimes referred to as ephemeral.
Inundation: a condition in which water from any source temporarily or permanently covers a land surface.
Kame: an irregular, short ridge or hill of stratified glacial drift.
Moraine: an accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, and ground.
Mineral soil: soil material in which inorganic (mineral) constituents predominate.
Nonpoint source pollution: pollution that enters a water body from diffuse origins on the watershed and does not result from discernible, confined, or discrete conveyances such as a pipe or ditch.
Normal high water mark of non-tidal waters: that line on the shores and banks of non-tidal waters which is discernible because of the different character of the soil or the vegetation due to the influence of surface water. Relative to vegetation, it is that line where the vegetation changes from predominantly aquatic to predominantly terrestrial (aquatic vegetation includes but is not limited to the following plants and plant groups – water lily, pond lily, pickerel-weed, cattail,

wild rice, sedges, rushes, marsh grasses; and terrestrial vegetation includes but is not limited to the following plants and plant groups – upland grasses, aster, lady slipper, wintergreen, partridge berry, sasparilla, pines, cedars, oaks, ashes, alders, elms, spruces, birches, beeches, larches, and maples). In places where the shore or bank is of such character that the normal high water mark cannot be easily determined (as in the case of rockslides, ledges, rapidly eroding or slumping banks), the normal high water mark shall be estimated from places where it can be determined by the above method.

Nutrients: essential chemicals needed by plants or animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and algal blooms. Some nutrients can be toxic at high concentrations. Elements or substances, such as nitrogen or phosphorus, that are necessary for plant growth.

Open wetland: non-forested wetland such as an emergent and scrub-shrub wetlands.

Organic horizon: an organic layer of fresh and decaying plant residue (*e.g.* leaves, needles and twigs) at the soil surface sometimes called duff.

Organic matter: plant and animal residue in the soil in various stages of decomposition.

Outwash plain: a landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material: the unconsolidated organic and mineral material in which soil forms.

Perennial stream: a stream with flowing water all year long.

Permeable soils: soil materials with a sufficiently rapid infiltration rate so as to greatly reduce or eliminate surface and stormwater runoff. These soils are generally classified as SCS hydrologic soil types A and B.

Permeability: the quality of the soil that enables water to move downward through the profile.

Pesticide: a chemical agent or substance employed to kill or suppress pests (such as insects, weeds, fungi, rodents, nematodes or other organisms) or intended for use as a plant regulator defoliant or desiccant.

Riparian buffer: naturally vegetated terrestrial area bordering streams and rivers.

River, stream or brook: a channel between defined banks. A channel is created by the action of surface water and has 2 or more of the following characteristics.

a. It is depicted as a solid or broken blue line on the most recent edition of the U.S. Geological Survey 7.5-minute series topographic map or, if that is not available, a 15-minute series topographic map.

b. It contains or is known to contain flowing water continuously for a period of at least 3 months of the year in most years.

c. The channel bed is primarily composed of mineral material such as sand and gravel, parent material or bedrock that has been deposited or scoured by water.

d. The channel contains aquatic animals such as fish, aquatic insects or mollusks in the water or, if no surface water is present, within the stream bed.

e. The channel contains aquatic vegetation and is essentially devoid of upland vegetation.

Runoff: the precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Salmon habitat: see Atlantic salmon habitat.
Sapling/shrub: a layer of vegetation composed of woody plants <3.0 in. in diameter at breast height but >3.2 ft in height, exclusive of woody vines.
Scrub-shrub wetlands: areas dominated by woody vegetation less than 6 meters (20 feet) tall. They are seasonally flooded and often saturated near the surface when not flooded. Common species include buttonbush, broad-leaved meadowsweet, steeple-bush, speckled alder, sweet gale, mountain holly, northern arrowwood, maleberry, silky dogwood, highbush blueberry, willows, and winterberry. Some shrub swamps are dominated by saplings of trees such as red maple, black spruce, and larch.
Sediment: fragmented material that originates from weathering and erosion of rocks or unconsolidated deposits, and is transported by, suspended in, or deposited by water.
Sedimentation: the depositing or formation of sediment. Removal, transport, and deposition of detached sediment particles by flowing water or wind.
Seep: diffuse groundwater discharge (see spring).
Significant sand and gravel aquifer: an area appearing on Maine Significant Sand and Gravel Aquifer maps. These aquifers typically occur coarse-textured glacial deposits such as glacial ice-contact (*e.g.* eskers, kames), ice stagnation, outwash, and alluvial deposits. Often the water table is within 25 feet of the land surface and water yields are high. Groundwater travels relatively rapidly in these aquifers (they are highly permeable).
Slope: the inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.
Soil: unconsolidated mineral and organic material that supports, or is capable of supporting, plants, and which has recognizable properties due to the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over time.
Soil horizon: a layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics (*e.g.* color, structure, texture, etc.).
Soil series: a group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.
Spring: groundwater discharge to the land surface. Areas of diffuse groundwater discharge are usually termed "seeps" whereas more obvious discharge flows are usually termed "springs". In Maine, as much as 40% of stream flow may be attributable to groundwater discharge. As used here, springs and seeps do not include perched groundwater discharge as is common on slowly permeable surficial materials such as compact tills (*e.g.* drumlins), but rather includes groundwater discharge with an apparent or direct connection to a regional aquifer such as commonly occurs where stream valleys are composed of sand and gravel deposits (*e.g.* glacial outwash, eskers).
Stream order: a number ranked from headwaters to river mouth that designates the relative position of a stream in a drainage basin. First-order streams have no discrete tributaries; the junction of two first-order streams forms a second-order stream; the junction of two second-order streams forms a third-order stream; etc.
Timber harvesting: the cutting and removal of trees from their growing site, and the attendant operation of mobile or portable chipping mills and of cutting and skidding machinery, including the creation and use of skid trails, skid roads, and winter haul roads, but not the construction or creation of land management roads.
Tributary: stream flowing into a lake or larger stream.

Turbidity: cloudiness of a liquid, caused by suspended solids; a measure of the suspended solids in a liquid.

Watermark: a line on a tree or other upright structure that represents the maximum static water level reached during an inundation event.

Watershed: total land area draining to any point in a stream.

Wetland functions: the roles wetlands serve which are of value to society or the environment including, but not limited to, flood water storage, flood water conveyance, ground water recharge and discharge, erosion control, bank stabilization, water quality protection, scenic and aesthetic use, food chain support, fisheries, wetland plant habitat, aquatic habitat and wildlife habitat.

APPENDIX A

PROJECT DATA FORM AND ATTACHMENTS

DATA FORM
RIPARIAN BUFFER CHARACTERISTICS
(ATLANTIC SALMON HABITAT PROTECTION)

Date: _________ **Evaluator(s): ___________________________**

River/Stream:_______________ **USGS Quadrangle: ______________________**

Latitude/longitude (optional if location shown on USGS Quad.)**: ______________________**

Buffer unit #: _____ **Stream order** (optional)**: _______**

Site location (describe):____
____

Data for Determining Start Point (i.e. Baseline) for Buffers

Floodplains and Adjacent Open Wetlands: Identify the landward edge of all floodplains and open wetlands (i.e. emergent and scrub-shrub wetlands) adjacent to the stream. These features are considered part of the stream zone being protected rather than part of the buffer. Begin buffer measurements at the landward edge of these features. **(check applicable item(s) below)**

Neither floodplains nor open wetlands occur immediately adjacent to the stream _____
(use the normal high water line of the stream as the baseline for buffer measurement)

Emergent and/or scrub-shrub wetland identified adjacent to stream _____
Floodplain identified adjacent to stream _____
(use the landward edge of these features as the baseline for buffer measurement)

Data for Use With Buffer Width Key (Primary Attributes)

Slope:	0-8% ____	**Soils:**	hydrologic soils group A ____
	8-15% ____		hydrologic soils group B ____
	15-25%____		hydrologic soils group C ____
	>25% ____		hydrologic soils group D ____

source/calculation method: ______________
____

source (*e.g*. County Soil Survey): ________
____

% Canopy Closure:

0-25%______ 26-50%_____ 51-75%_____ 76-100%____

source/calculation method (*e.g.* recent aerial photo, field determination): ___________________
____

Additional Data Used to Adjust Buffer Width (Secondary Attributes)

Surface Water Features: (check all that apply)

no surface water features located in the buffer: _____

(no adjustment to buffer width)

intermittent stream: _____

perennial stream: _____

ditch or swale: _____

other (e.g. pond connected to river by culvert or outlet stream): _____

(add 50' to zone 2; in addition, maintain a 35' no-harvest strip adjacent to perennial surface water features in zone 2)

Exception: if the surface water feature is not connected to the in-stream habitat being protected by means of surface drainage no adjustment is made (e.g. isolated pond).

Note: surface water features as defined here include the State of Maine (e.g. NRPA regs) definition of river, stream or brook in addition to constructed ditches and swales that carry stormwater drainage to the in-stream habitat being protected.

source (*e.g*. field work, USGS map, NWI map, aerial photo): ______________________

____

Note: *If surface water features are identified in the field but are not indicated on available map resources, locations should be shown on map.*

Groundwater Seepage or Springs: (check one)

Spring(s)/groundwater seepage present in buffer (note # and approx. locations): _______

____

(add 25' to zone 2)

Springs/groundwater seepage not present in buffer _____

Could not determine if spring/seepage present or not _____ (in some cases it will not be possible to positively identify springs/groundwater seepage based on field observation)

(no adjustment to buffer width)

Basis:____

____

Note: A field indicator of springs is relatively constant discharge of cool water (in Maine, usually 4.4° C to 10.0° C) to the surface. Typically there is not surface water inflow, yet water trickles/seeps out. Often there is a seepage wetland or small spring-fed stream associated with these groundwater discharge features. Perched or shallow subsurface drainage seeps not directly connected to the underlying aquifer should not be counted (groundwater discharge in areas of highly permeable glacial deposits should be assumed to be connected to the underlying aquifer). Springs/seeps often occur on lower portions of side-slopes adjacent to streams. In Washington County, springs are often associated with highly permeable glacial deposits.

Surface Roughness: (check one)

High degree of surface roughness:_____
(subtract 25' from zone 2)
Typical or Moderate degree of surface roughness:____
(no adjustment to buffer width)
Low degree of surface roughness: _____
(add 25' to zone 2)

Note: Refer to Attachment C (surface roughness guidelines). Surface roughness features include:

- coarse woody debris ($\geq$ 2 cm)
- rotten stumps or logs typically covered with moss
- boulders or rocks
- herbaceous vegetation
- pit and mound or undulating topography (complex/rough microtopography); a portion of the land surface slopes away from the stream
- intact duff layer (surface organic horizon)/lack of exposed mineral soils

Buffer has exposed mineral soils (i.e. duff layer not intact) as a result of human activity: ____
(automatically low degree of surface roughness; add 25' to zone 2)
Buffer does not have exposed mineral soils as a result of human activity: ____
(typical or high degree of surface roughness; no change or subtract 25'– see Attach. C)
If exposed mineral soils, note cause (if known): ____________________________________
____

Sand and Gravel Aquifers: **(check one)**

Mapped Significant Sand and Gravel Aquifer (or any portion of such a feature) occurs in buffer ____
(add 25' to zone 2)
Mapped Significant Sand and Gravel Aquifer does not occur in buffer ____
(no adjustment to buffer width)

Wetlands: (check all that apply)

Isolated wetland (not connected to stream by surface drainage) occurs in buffer ____
Wetland directly connected to stream by surface drainage occurs in buffer ____
(add 25' to zone 2 for the presence of any wetland area, regardless of whether it is isolated or connected; further expand zone 2 to encompass the entire wetland for any wetland that is at least partly in the buffer and is connected to the stream being protected by means of intermittent or perennial surface flows)

No wetlands located in the buffer ____
(no adjustment to buffer width)

source (*e.g*. field work, NWI map): ____
____

Very Steep Slopes (*i.e.* >25%): Note all areas in the buffer that have very steep slopes. **(check one)**

Very steep slopes identified in buffer area ___

(expand zone 2 as necessary to encompass the entire area of very steep slopes)

Very steep slopes not located in buffer area ___

(no adjustment to buffer width)

Additional Information

Soil Series and Surficial Geology:

Soil Series (from Soil Survey or professional assessment):____________________________

Surficial geologic material(s) in buffer: ____

Note: this data does not result specific additional adjustments to the buffer width but this information may help identify soil characteristics, aspects of water movement through the buffer, and areas sensitive to potential groundwater contamination.

Identifiable Land Uses:

	Type of land use	location/coverage	source (e.g. field work)
1.	________________________	________________________	________________________
2.	________________________	________________________	________________________
3.	________________________	________________________	________________________

Note*: Land uses affect buffer attributes such as % canopy cover, surface roughness, and soil hydrologic group (infiltration capacity). These, in turn, affect optimal buffer width. But additional buffer width adjustments are not made as a result of specific land use practices historically occurring in the buffer. There are recommended land use restrictions in the buffer zone (zone 1 and zone 2), however in many cases it is impractical to eliminate historical uses in these zones. Best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer (e.g. establish woody vegetation).*

Note any differences between actual field conditions and desk-top data collected (field data should generally take precedent over desk-top data)**:**

____
____
____
____
____
____

Other Notes:

____
____
____

WORKSHEET
BUFFER # _____

1. **Length of buffer unit along baseline/stream *: _________**

2. **Width of buffer unit used to measure/determine buffer attributes (i.e. not the same as optimal buffer width – use Attachment B): _________**

3. **Unadjusted buffer width from key: _________**

4. **Adjust number from the key to account for those factors that result in specific increases or decreases in buffer width:**

Adjustment for surface water features:	______	=	______
Adjustment for groundwater seepage/springs:	______	=	______
Adjustment for surface roughness:	______	=	______
Adjustment for signif. sand & gravel aquifers:	______	=	______
Adjustment for wetlands:	______	=	______

Adjusted Buffer Width: _____

5. **Finally, expand the buffer width as necessary to include:**
   a. all areas of very steep (i.e. >25%) slopes that are at least partially within the adjusted buffer width (as determined in step 2), and
   b. all wetlands connected to the salmon stream by surface drainage that are at least partially within the adjusted buffer width (as determined in step 2)

   Describe adjustments made, if any, for very steep slopes: __________________________
   ____

   Describe adjustments made, if any, for connected wetlands: ________________________
   ____

* The length of buffer units should be no more than 300’ along the baseline of the stream reach being protected (the baseline is parallel to the normal high water mark of the stream or, if there are adjacent floodplains or open wetlands, the baseline is parallel to the landward edge of these features). Evaluators should not be constrained by this number, however, and may choose smaller lengths so that breaks between buffer units coincide with logical changes in buffer attributes, such as abrupt changes in slope, soils, % canopy cover, or wetlands.

List of Attachments to Data Form
(Attachments to Appendix A)

Attachment A	Buffer Width Key
Attachment B	Table to Determine Portion of the Buffer to Measure Attributes in
Attachment C	Surface Roughness Guidelines
Attachment D	Guidelines for Estimating Percent Coverage
Attachment E	Soil Hydrologic Group and Other Useful Information for Maine Soil Series
Attachment F	Surficial Geology/Soil Hydrologic Group Correlation

Attachment A
Optimal Buffer Width Key
Combined Zone 1 and 2 Unadjusted* Widths
For Atlantic Salmon Habitat Conservation

1. Slopes 0-8%
    2. hydrologic group A and B soils
        3. % canopy closure 76-100%…………………….70’
        3. % canopy closure 51-75%…………………….. 80’
        3. % canopy closure 26-50%…………………….. 90’
        3. % canopy closure 0-25%……………………… 100’

    2. hydrologic group C soils
        3. % canopy closure 76-100%…………………….90’
        3. % canopy closure 51-75%…………………….. 100’
        3. % canopy closure 26-50%…………………….. 110’
        3. % canopy closure 0-25%……………………… 120’

    2. hydrologic group D soils
        3. % canopy closure 76-100%…………………….110’
        3. % canopy closure 51-75%…………………….. 120’
        3. % canopy closure 26-50%…………………….. 130’
        3. % canopy closure 0-25%……………………... 140’

1. Slopes 8-15%
    2. hydrologic group A and B soils
        3. % canopy closure 76-100%…………………….100’
        3. % canopy closure 51-75%…………………….. 110’
        3. % canopy closure 26-50%…………………….. 120’
        3. % canopy closure 0-25%……………………… 130’

    2. hydrologic group C soils
        3. % canopy closure 76-100%…………………….120’
        3. % canopy closure 51-75%…………………….. 130’
        3. % canopy closure 26-50%…………………….. 140’
        3. % canopy closure 0-25%……………………… 150’

    2. hydrologic group D soils
        3. % canopy closure 76-100%…………………….140’
        3. % canopy closure 51-75%…………………….. 150’
        3. % canopy closure 26-50%…………………….. 160’
        3. % canopy closure 0-25%……………………... 170’

1. Slopes 15-25%
    2. hydrologic group A and B soils
        3. % canopy closure 76-100%……………………….130’
        3. % canopy closure 51-75%……………………….. 140’
        3. % canopy closure 26-50%……………………….. 150’
        3. % canopy closure 0-25%……………………….. 160’

    2. hydrologic group C soils
        3. % canopy closure 76-100%……………………….150’
        3. % canopy closure 51-75%……………………….. 160’
        3. % canopy closure 26-50%……………………….. 170’
        3. % canopy closure 0-25%……………………….. 180’

    2. hydrologic group D soils
        3. % canopy closure 76-100%……………………….170’
        3. % canopy closure 51-75%……………………….. 180’
        3. % canopy closure 26-50%……………………….. 190’
        3. % canopy closure 0-25%……………………….... 200’

1. Slopes >25%
    2. hydrologic group A and B soils
        3. % canopy closure 76-100%……………………….160’
        3. % canopy closure 51-75%……………………….. 170’
        3. % canopy closure 26-50%……………………….. 180’
        3. % canopy closure 0-25%……………………….. 190’

    2. hydrologic group C soils
        3. % canopy closure 76-100%……………………….180’
        3. % canopy closure 51-75%……………………….. 190’
        3. % canopy closure 26-50%……………………….. 200’
        3. % canopy closure 0-25%……………………….. 210’

    2. hydrologic group D soils
        3. % canopy closure 76-100%……………………….200’
        3. % canopy closure 51-75%……………………….. 210’
        3. % canopy closure 26-50%……………………….. 220’
        3. % canopy closure 0-25%……………………….... 230’

* This key yields unadjusted optimal buffer widths which are subsequently adjusted to account for the presence of other important buffer variables such as wetlands, surface water features, springs, significant sand and gravel aquifers, surface roughness, and very steep slopes.

Attachment B

Table to Determine the Portion of the Buffer to Measure

Buffer Attributes in

In order to determine the portion of the riparian buffer to gather attribute data for, start by determining slope in the area between 0-100’, and proceed as necessary through the table presented below.

If slope is:	Then measure buffer attributes in this portion of the buffer:
<8% in area between 0-100’	0-100’
8-15% in area between 0-100’ but <8% in area between 0-150’	0-125’
8-15% in area between 0-100’ and 8-15% in area between 0-150’	0-150’
>15% in area between 0-100’ but <15% in area between 0-200’	0-175’
>15% in area between 0-100’ and >15% in area between 0-200’	0-200’

Rationale: At the start of the evaluation, the optimal buffer width is not yet known. Since slope is the most important readily-measurable buffer attribute affecting buffer function, this is a good way to get a quick initial approximation of the ultimate outcome as an indication of how far landward to measure buffer attributes. As a consequence, the optimal buffer width generated may not be identical to the width of buffer being measured but should be similar.

Attachment C
Surface Roughness Guidelines

High Degree of Surface Roughness: Buffers with a high degree of surface roughness have the following characteristics:

- The microtopography is complex. Often there is pit-and-mound or undulating topography resulting from fallen trees so that a portion of the land slopes away from the stream. The land surface does not slope smoothly and consistently towards the stream.
- The buffer unit is forested. Non-forested buffers either have a typical or a low degree of surface roughness (see below). Non-forested buffers allow greater quantities of runoff to reach the stream and are more susceptible to concentrated flow patterns.
- The surface organic horizon (duff layer) is intact throughout the buffer unit. If exposed mineral soil related to human use (e.g. dirt roads, skid trails where the surface organic horizon has been removed down to mineral material) occurs anywhere in the buffer, then there is automatically a low degree of surface roughness. Areas of exposed mineral soil often become concentrated flow paths for runoff. Natural occurrences of mineral soils such as tip-ups (trees that fall over bringing the root crown and attached mineral soils to the soil surface) may be present.
- Dead-and-down wood and rotting logs and stumps are common. Specifically, coarse woody debris ($\geq$ 2 cm) is scattered about the forest floor and older woody debris is being incorporated into the organic horizon and often appears as mossy lumps on the forest floor.
- Often, there is a well-developed herb layer. However, in heavily shaded coniferous forests this will not always be the case, and a dense herb layer is not necessary for a high degree of surface roughness as long as other factors are present.
- Often moss-covered boulders are common and, where present, add to microtopographical complexity. This feature is not required and may not be present in many cases, such as where the surficial geology consists of glacial marine deposits or outwash.
- $\geq$ 30% by aerial coverage of the land surface contains surface roughness features. Surface roughness features include: coarse-woody debris, herbaceous vegetation, rotten stumps and logs, boulders, and land that slopes away from the stream. (note: see attachment B for estimating percent coverage)

Typical (or Moderate) Degree of Surface Roughness: Buffers with a typical degree of surface roughness have the following characteristics:

- Between 5 and 30% by aerial coverage contains surface roughness features. (see above for surface roughness features)
- For an open (non-forested) system, it must not be mowed or hayed or intensively managed (e.g. blueberry barrens) and vegetation must be rough, and dense. Usually there will be clumps of woody vegetation becoming established due to lack of mowing. Also there must be surface roughness features other than herbaceous vegetation, such as woody debris, boulders or humocky topography over at least 5% of the land surface by aerial coverage. These areas are often recently abandoned agricultural lands and will typically revert to forest.
- The surface organic horizon (duff layer) is intact throughout the buffer unit. (see above)

Low Degree of Surface Roughness: Buffers with a low degree of surface roughness have the following characteristics:

- <5% by aerial coverage of the land surface contains surface roughness features. (see above for surface roughness features)
- Buffer units with exposed mineral soils as a result of human use automatically have a low degree of surface roughness, as do managed (e.g. areas that are mowed or used for agriculture) areas.

Photo 1. **High Degree of Surface Roughness.** At least 30% of the land surface contains surface roughness features such as coarse woody debris, rotten logs covered with moss, herbaceous vegetation and land that slopes away from the stream. The photo was taken in November, after the growing season, so that some of the herb vegetation had to be estimated based on evidence such as dead, persistent stems. The pit and mound topography in this photo is typical of buffers with a high degree of surface roughness.

Photo 2. Same as Photo 1.

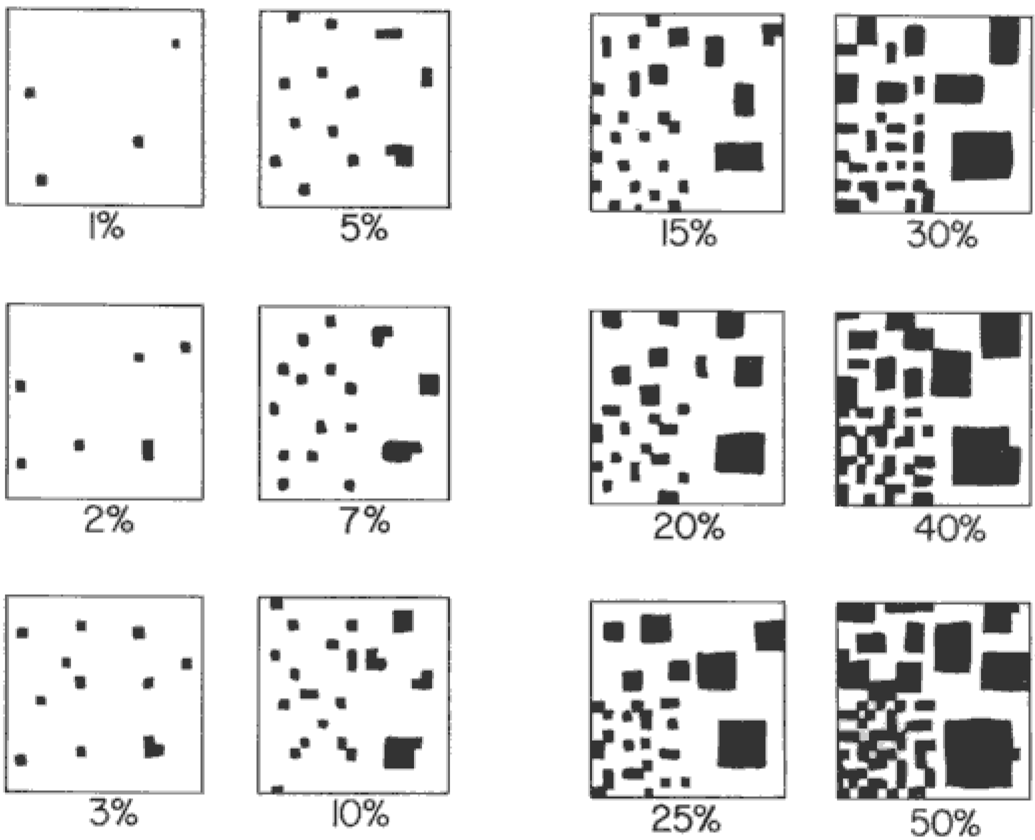
Photo 3. **Typical (Moderate) Degree of Surface Roughness.** This recently abandoned field is beginning to form clumps of woody vegetation, has dense, rough herbaceous vegetation, and has microtopographical features that slope away from the general slope of the land (although this last characteristic is difficult to see because of the angle of the photograph). 5% or more of the land surface consists of boulders, back-sloping land or woody debris. The surface organic horizon is well-developed throughout.

Photo 4. **Typical (Moderate) Degree of Surface Roughness.** This young, second-growth forest has little microtopographical complexity. However, between 5 and 30% of the land surface contains herbaceous vegetation, coarse woody debris or stumps. Since the photo was taken in November, some of the herbaceous vegetation had to be estimated. The surface organic horizon is well developed throughout.

Photos 5, 6, 7 and 8. **Low Degree of Surface Roughness.** In all photos, either <5% of the land surface contains surface roughness features or the land is mowed/maintained.

Photos 9,10 & 11. **Low Degree of Surface Roughness.** In the absence of the dirt road in Photo 9 (upper left) this buffer might have a typical to high degree of surface roughness. Photo 10 (right) shows the side-slope of a section of the road shown in Photo 9 where leaf and needle litter has been washed downslope by runoff from the road. Buffers containing roads or other exposed mineral soil areas related to human use have a low degree of surface roughness. The blueberry barren in Photo 11 (lower left) has a low degree of surface roughness since it is in agriculture and is routinely managed.

Attachment D
Guidelines for Estimating % Coverage or % Canopy Closure



Note: To estimate percentages >50% use white portions instead of black. (e.g., to get an idea of what 75% looks like, look at 25% and use the white instead of the black). Each fourth of any one square has the same amount of black. Source: Munsell Soil Color Charts (1994, revised edition).

ATTACHMENT E

SOIL HYDROLOGIC GROUPS AND OTHER USEFUL INFORMATION FOR SOIL SERIES MAPPED IN MAINE

Source: "Engineering Criteria for Soil Series Mapped in Maine", USDA Soil Conservation Service (March, 1992).

Notes: Soil names no longer used in Maine are referenced to a current name with the same hydrologic group. Hydrologic group designations are taken from the SCS Soil Interpretation Record. Soil data is updated periodically and is subject to change. The "hydric" status column was included as an aid to wetlands identification and the "perched" designation added to help determine the presence of springs (*e.g.*, seeps in perched situations can be differentiated from springs that are directly connected to underlying aquifers). In developed areas with a high percentage of impervious surfaces (e.g. soils mapped as Udorthents or Udorthents-Urban land Complex), the hydrologic group should be assumed to be D.

An asterisk (*) indicates soils that are potential sand and gravel aquifer soils as listed in the publication, "Soil Survey Data for Growth Management in Washington County", USDA NRCS (September, 1997). As a result of the rapid permeability of the sandy and gravelly parent materials associated with these soils, pollutants can move quickly through the soil profile and enter the underlying aquifer/groundwater (NRCS, 1997). Two asterisks (**) indicate recent floodplain soils as listed in Chapter 1000: Guidelines for Municipal Shoreland Zoning Ordinances (ME DEP, 1994).

Series Name	Hydrologic Group	Hydric	Kind
Abram	D	N	
Adams*	A	N	
Agawan (See Groveton)			
Allagash	B	N	
Alluvial**	B/D	Y/N	
Atherton	B/D	Y	Apparent
Au Gres (See Nausburg)			
Aurelie	D	Y	Perched
Bangor	B	N	
Becket	C	N	Perched
Belgrade (See Nicholville)			
Benson	D	N	
Berkshire	B	N	
Beseman	A/D	Y	Apparent
Biddeford	D	Y	Apparent
Boothbay	C	N	Apparent
Borohemist (See Chocorua)			
Borosaprist (See Bucksport)			
Brayton	C	Y	Perched
Bucksport	D	Y	Apparent
Burnham	D	Y	Apparent
Buxton	C	N	Apparent
Canaan	C	N	
Caribou	B	N	

Series Name	Hydrologic Group	Hydric	Kind
Cathro	A/D	Y	Apparent
Charles**	C	Y	Apparent
Charlton (See Berkshire)			
Chesuncook	C	N	Perched
Chocorua	D	Y	Apparent
Colonel	C	N	Perched
Colton*	A	N	
Conant	C	N	Apparent
Cornish**	C	N	Apparent
Crary	C	N	Perched
Creasey	C/D	N	
Croghan*	B	N	Apparent
Daigle	C	N	Perched
Danforth	B	N	
Deerfield (See Croghan)			
Dixfield	C	N	Perched
Dixmont	C	N	Perched
Duane	B	N	Apparent
Easton	D	Y/N	Apparent
Eldridge (See Elmwood)			
Elliottsville	B	N	
Elmwood	C	N	Perched
Enchanted	B	N	
Finch	C	N	Perched
Fredon	C	Y/N	Apparent
Fryeburg**	B	N	
Gloucester (See Hermon)			
Gouldsboro	D	Y	Apparent
Greenwood	A/D	Y	Apparent
Groveton	B	N	
Hadley (See Fryeburg)**			
Halsey	C/D	Y	Apparent
Hermon*	A	N	
Hermon Variant, Bedrock Substratus	C	N	
Hinkley (See Colton)			
Hollis (See Lyman)			
Howland	C	N	Perched
Ipswich	D	Y	Apparent
Kinsman*	C	Y/N	Apparent
Lamoine	D	N	Perched
Leicester (See Bravton)			
Lille	B	N	
Linneus	B	N	
Limerick (See Charles)			
Lovewell**	B	N	Apparent
Loxley	A/D	Y	Apparent
Lupton	A/D	Y	Apparent
Lyman	C/D	N	
Lyme	C	Y/N	Apparent

Series Name	Hydrologic Group	Hydric	Kind
Machias	B	N	Apparent
Madawaska	B	N	Apparent
Mahoosuc	A	N	
Mapleton	C	N	
Mapleton, Stony	C/D	N	
Marlow	C	N	Perched
Masardis*	A	N	
Masardis Variant, Bedrock Substratus	C	N	
Medomak**	D	Y	Apparent
Melrose	C	N	
Merrimac (See Stetson)			
Monadnock	B	N	
Monarda	D	Y	Perched
Monson	C/D	N	
Moosilauke	C	Y/N	Apparent
Naskeag	C	Y/N	Apparent
Naumburg	C	N	Apparent
Naumburg, poorly drained	C	Y	Apparent
Nicholville	C	N	Perched
Ninigret (See Madawaska)			
Ondawa	B	N	
Ossipee	D	Y	Apparent
Pawcatuck	D	Y	Apparent
Paxton (See Marlow)			
Peachan	D	Y	Apparent
Penquis	B	N	
Perham	B	N	Perched
Peru	C	N	Perched
Plaisted	C	N	Perched
Podunk**	B	N	Apparent
Potsdam	C	N	Perched
Raynham (See Roundabout)			
Red Hook	C	N	Apparent
Ricker	A	N	
Ridgebury (See Brayton)			
Rifle	A/D	Y	Apparent
Roundabout	C	Y/N	Apparent
Rumney**	C	Y/N	Apparent
Saco (See Medomak)**			
Saddleback	C/D	N	
Salmon	B	N	
Saprists (See Bucksport)			
Saugatuck (See Finch)			
Scantic	D	Y	Perched
Scarboro (See Searsport)			
Schoodic	D	N	
Scio (See Nicholville)			
Searsport	D	Y	Apparent
Sebago	D	Y	Apparent

Series Name	Hydrologic Group	Hydric	Kind
Sheepscot*	B	N	Apparent
Shirley	B	N	Apparent
Sisk	C	N	
Skerry	C	N	Perched
Skowhegan	B	N	Apparent
Stetson	B	B	
Suffield (See Buxton)			
Sulfaquents (See Pawcatuck)			
Sulfihemists (See Pawcatuck)			
Sunday**	A	N	
Surplus	C	N	Perched
Swanton	C/D	Y/N	Apparent
Swanville	C	Y	Apparent
Telos	C	N	Apparent
Thorndike	C/D	N	
Togus	D	Y	Apparent
Tunbridge	C	N	
Udorthents or Udorthents-Urban Complex	D (assumed)	Y/N	
Vassalboro	D	Y	Apparent
Walpole (See Moosilauke)			
Washburn	D	Y	Apparent
Waskish	D	Y	Apparent
Wauebek	B	N	Apparent
Westbrook	D	Y	Apparent
Westbury	C	N	Perched
Whately	D	Y	Apparent
Windsor (See Adams)			
Winnecook	C	N	
Winooski (See Lovewell)**			
Whitman (See Peacham)			
Wonsqueak**	D	Y	Apparent
Woodbridge (See Peru)			

ATTACHMENT F

SURFICIAL GEOLOGY/SOIL HYDROLOGIC GROUP CORRELATION

Note: This table should be used to determine soil hydrologic group only as a last resort (*e.g.*, if soil series is not known). This table should only be viewed as a means of roughly approximating soil hydrologic group. There is a range of potential hydrologic groups for many surficial materials. This table is intended to provide the most likely hydrologic group for a given surficial material. **All wetland soils regardless of parent material (surficial material) should be considered D** if the soil series is unknown (a few wetland soils are C, but the vast majority are D). Surficial Geologic Units are from the Surficial Geology Map of Maine (ME DOC, 1985). More detailed Reconnaissance Surficial Geology maps are available for a few quadrangles from the Maine DOC Information and Mapping Center.

Geologic Unit	Materials	Probable Soil Hydrologic Group
Stream alluvium (includes Holocene flood plain, stream terrace, and alluvial fan deposits)	Sand, gravel, and silt.	C Note: if this surficial material is present and soil survey data is not available, a field evaluation should be conducted to determine the edge of the floodplain. Hydrologic group is unimportant since floodplains are considered to be part of the river itself rather than part of the buffer being evaluated.
Swamp, marsh, and bog deposits (includes both fresh-water and salt-water marshes)	Peat, muck, clay, silt, and sand.	D
Beach deposits	Sand and gravel.	A
Emerged beach deposits	Sand and gravel.	A
Eolian deposits	Sand.	A
Lake-bottom deposits	Silt, clay, and sand. Commonly well stratified, and may be rhythmically bedded.	C
Glaciomarine deposits (fine-grained facies)	Silt, clay, sand, and minor amounts of gravel. Commonly a clayey silt (e.g. of the Presumpscot Formation). Sand is dominant in some places, but may be underlain by finer-grained sediments. Locally fossilferous. Map unit includes small areas of till and other units that are not completely covered by marine sediments.	C

Geologic Unit	Materials	Probable Soil Hydrologic Group
Glacoimarine deposits (coarse-grained facies)	Sand, gravel, and minor amounts of silt.	B
Glacial outwash deposits	Sand and gravel.	A
Ice-contact glaciofluvial deposits (exclusive of eskers)	Sand, gravel, and silt.	A
Eskers	Gravel and sand. May include minor amounts of till. Portions of many eskers below the marine limit are partly or entirely buried by glaciomarine deposits.	A
Stagnation moraine	Mostly till, but also includes variable percentages of undifferentiated sand and gravel.	B (highly variable)
End moraines	Till or sand and gravel. May be very bouldery. Commonly interbedded with or overlain by glaciomarine sediments in areas that experienced late-glacial marine submergence.	B (highly variable)
Ribbed moraine	Till is the principal constituent, but stratified sediments are present in some of the deposits.	B
Till	Heterogeneous mixture of sand, silt, clay, and stones. May include may boulders. Generally massive, but in many places contains beds and lenses of variably washed and stratified sediments.	B (exception: C if compact till such as on a drumlin)
Thin drift	Area of many bedrock outcrops and/or thin surficial deposits (generally less than 3 m thick). The type of surficial material is know or inferred.	C
Thin drift, undifferentiated	Area of many bedrock outcrops and/or near-surface bedrock where the surficial materials have not been mapped.	C
Bedrock	Area of extensive bedrock outcrop, or where the bedrock has only a thin cover of soil and vegetation. Surficial	D

Geologic Unit	Materials	Probable Soil Hydrologic Group
	deposits are essentially absent. Particularly common on the ridge crests and steeper slopes of mountainous areas.	

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APPENDIX B

EXAMPLE BUFFER EVALUATION

Example Buffer Evaluation

Site: Crebo Crossing, T 18 MD BPP, Washington County, Maine
(from the Crebo bridge crossing north approximately 1,100’ along the east side of Pleasant River)

Note: Cherryfield Foods, Inc owns the evaluation area. Cherryfield granted the Maine State Planning Office and Kleinschmidt Associates permission to conduct the buffer evaluation on their property.

This example buffer evaluation has been included as an appendix in order to illustrate aspects of an actual buffer evaluation (e.g. how to fill-out the data forms, how to calculate optimal buffer widths using the worksheet at the end of the data sheets, etc.). The Crebo Crossing evaluation area was broken-down into 5 buffer units. To the extent possible, breaks between buffer units were chosen to coincide with logical changes in the landscape or in buffer attributes (see figure B-1). For example, the break between Buffer Unit #3 and #4 was chosen so that Buffer Unit #3 contained the bend in the dirt road and #4 was entirely forested. Data sheets and worksheets for all five buffer units are attached. The results of the optimal buffer width calculations are displayed as a table in Figure B-1. Figures B-1 through B-5 show the location of the evaluation area on available map resources:

B-1 1998 color aerial
B-2 Soil Survey
B-3 USGS Topographic
B-4 Significant Sand and Gravel Aquifer
B-5 National Wetlands Inventory

It is important to note that any map can be used as a base map to show buffer unit locations and optimal buffer widths. In this case a recent aerial photo (Figure B-1) was used since it was good quality and clearly showed many of the features of interest in the evaluation (*e.g.* river, road, forest vs open cover, wetlands/floodplains, etc.). However, any number of map types (*e.g.* topographic map or site plan specific to site) may be used to show buffer unit configurations and optimal buffer widths. Once the baseline is determined and optimal buffer widths for each buffer unit are calculated, a continuous optimal buffer width line for the evaluation area can be marked in the field (e.g. using flagging, stakes or blazes). Survey location, use of compass and tape measure, and GPS (preferably with sub-meter accuracy) include methods of locating optimal buffer width points in the field.

The attached data sheets give the sources and calculation methods for the data used to determine buffer width. In addition, the following discussion is intended to help clarify aspects of the optimal buffer width determination not apparent from the data sheets.

The site was evaluated in the field on December 3, 1998. Typically, field work in Maine would not be possible at this time of year, since snow cover impedes accurate assessment of many buffer attributes (e.g. surface roughness, seeps/springs, wetlands, and floodplains). On this December 3, however, there was no snow or ice cover, soils were not frozen, and the land surface and forest floor were visible. Non-persistent herbaceous plant species are not apparent outside of the growing season. However, surface roughness categories were obvious in every buffer unit regardless of herbaceous cover (i.e. the inability to accurately assess herbaceous cover was not a problem). In general, it is preferable to conduct the field aspects of buffer evaluations during the growing season.

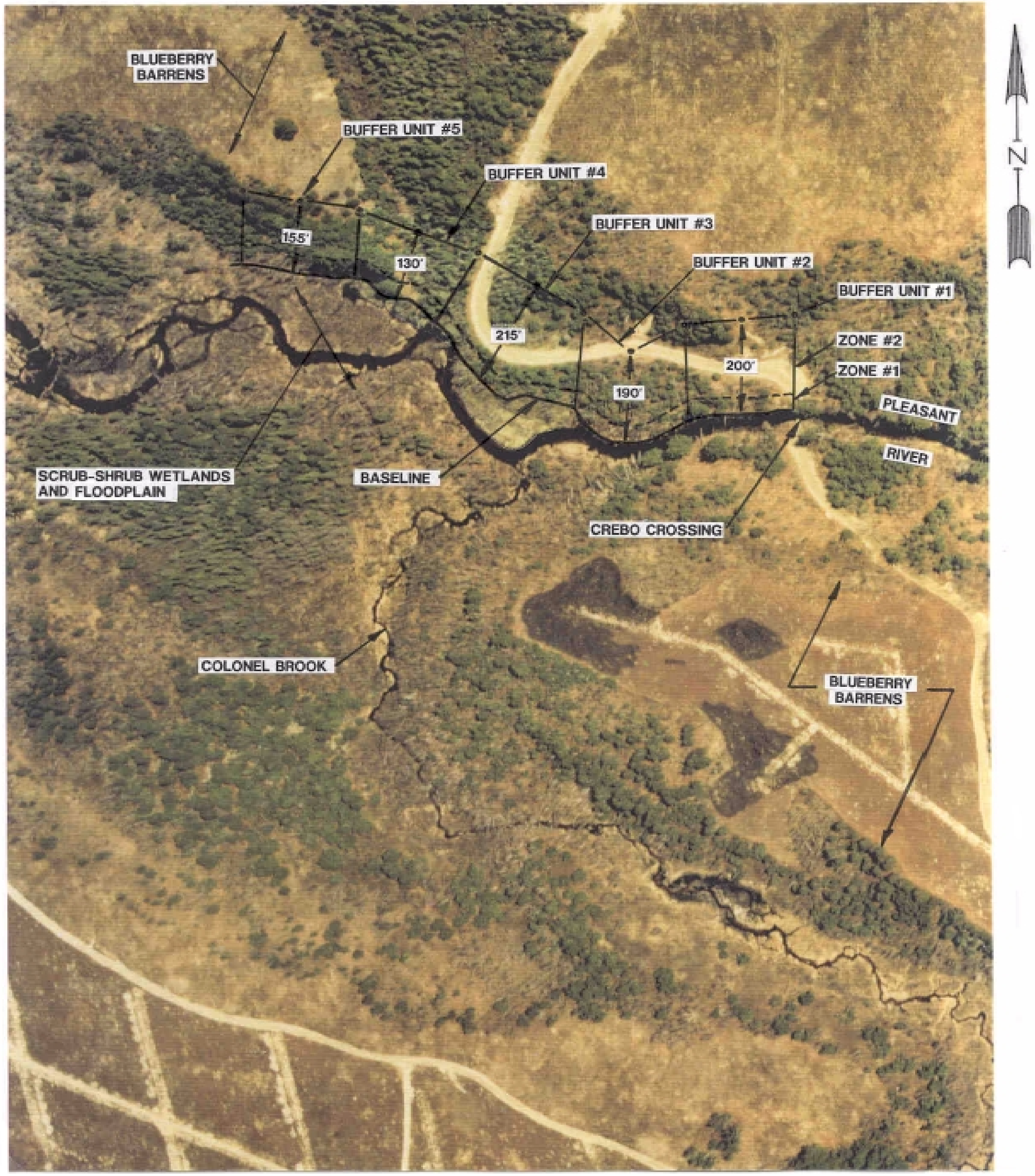
The entire evaluation area (all five buffer units) was determined to have Colton-Adams complex, 15-70% soils. This is a non-hydric (upland) soils unit that is classified as hydrologic group A and has potential for sand and gravel aquifer development (see Attachment E, Appendix A). The soils unit to the west of the baseline for buffer units #3 through #5 is Kinsman-Wonsqueak, 0-3% slopes. Soils in this association may or may not be floodplains or wetlands since it is a complex of two soils units. Whereas Wonsqueak is a floodplain and a wetland, Kinsman is not necessarily either (see Attachment E, Appendix A). Field work revealed that the entire area mapped as Kinsman-Wonsqueak complex was both a floodplain and a scrub-shrub wetland. The NWI mapping backed-up this assessment since the area is mapped as a scrub-shrub wetland. Therefore, the eastern edge of the Kinsman-Wonsqueak soil forms the baseline for buffer units #3 through #5. The baseline for buffer units #1 and #2 is the normal high water mark of the river since the soils mapping shows Colton-Adams complex soils (this soil is neither a floodplain or a wetland soil) to the river edge, NWI maps show no wetlands in this area, and the field work and recent aerial photo corroborate both of these mappings.

All five buffer units were determined to have Colton-Adams complex, 15-70% soils. Typically soils units are associated with a more narrow range of slopes that coincide with the slope categories for this method. In this case, we had to determine in the field whether the slope category was 15-25% or >25%. One method to get a quick approximation of slope in the field is to use a clinometer (preferably one that has both degrees and percent slope). In this case, it was determined in the field that the slope was much closer to 15% than to 25% for all five buffer units.

The Significant Sand and Gravel Aquifer Map shows that the entire evaluation area is mapped as a significant sand and gravel aquifer, which is to be expected since the soils are formed in glacial sand and gravel deposits. There is no available mapping to indicate the presence or absence of groundwater discharge to the soil surface as springs or seeps, however one spring was found to be located within buffer unit #3 in the field. The feature was determined to be a spring based on the fact that there was a trickle of cool water discharging from a relatively concentrated area despite the fact that there were no surface flows to the area and it had not rained in several days (i.e. the source was not direct precipitation or overland flows). The coarse-textured sand and gravel deposits and surficial material comprising the soils, as well as the landscape position it was observed in (i.e. on slight slope near bottom of stream valley) indicates that such a feature is most likely the result of the underlying aquifer intercepting the land surface (see Attachment E, Appendix A). If the spring were located on an area of compact till or shallow-to-bedrock soils, the feature would more likely be perched (separated from the underlying aquifer by a confining layer). Note that it could well be a clay lens or other isolated discontinuity in the area’s surficial geology that causes the groundwater to discharge in this specific place by perching the groundwater in an isolated area, but it is safe to assume a direct connection to the underlying aquifer due to the highly permeable sand and gravel deposits that comprise the general area.

Percent canopy coverage was determined by visual estimate/best professional judgement both in the field as well as using the aerial photo in Figure B-1. It was not necessary in this case to conduct a detailed quantitative analysis to determine percent canopy cover. However such a detailed analysis could be conducted if desired using a densiometer (hand-held instrument used to estimate canopy coverage percentages) in the field or using a dot grid superimposed on a recent aerial. In most cases, percent canopy coverage can easily be visually estimated since there are only four categories with a range of 25% canopy coverage in each category. Since the aerial for this site was flown in April, deciduous trees were not leafed-out. Furthermore, the field evaluation was conducted after leaf-off. This does not preclude percent canopy coverage estimates, however, since deciduous tree crowns are apparent and evaluators can assume that the trees are alive.

Sources and methods for determining remaining data (e.g. surface roughness, surface water features) are apparent from the data sheets.



Summary of Optimal Buffer Widths for the Crebo Crossing Buffer Evaluation Area

Buffer Unit	Calculated Optimal Buffer Width (zone 1 & zone 2 combined) (ft)*	Zone 1 Width (ft)	Zone 2 Width (ft)	Length of Buffer Unit Along Baseline (ft)**
#1	200'	35'	165'	200'
#2	190'	35'	155'	220'
#3	215'	35'	180'	300'
#4	130'	35'	95'	190'
#5	155'	35'	120'	220'

* Measured perpendicular to the baseline in the center of the buffer unit.

** Measured parallel to the baseline. Buffer unit lengths along the baseline should be a maximum of 300'; there is no minimum length. Breaks between buffer units can be chosen to coincide with logical changes in the landscape (e.g. an abrupt change in % canopy cover).

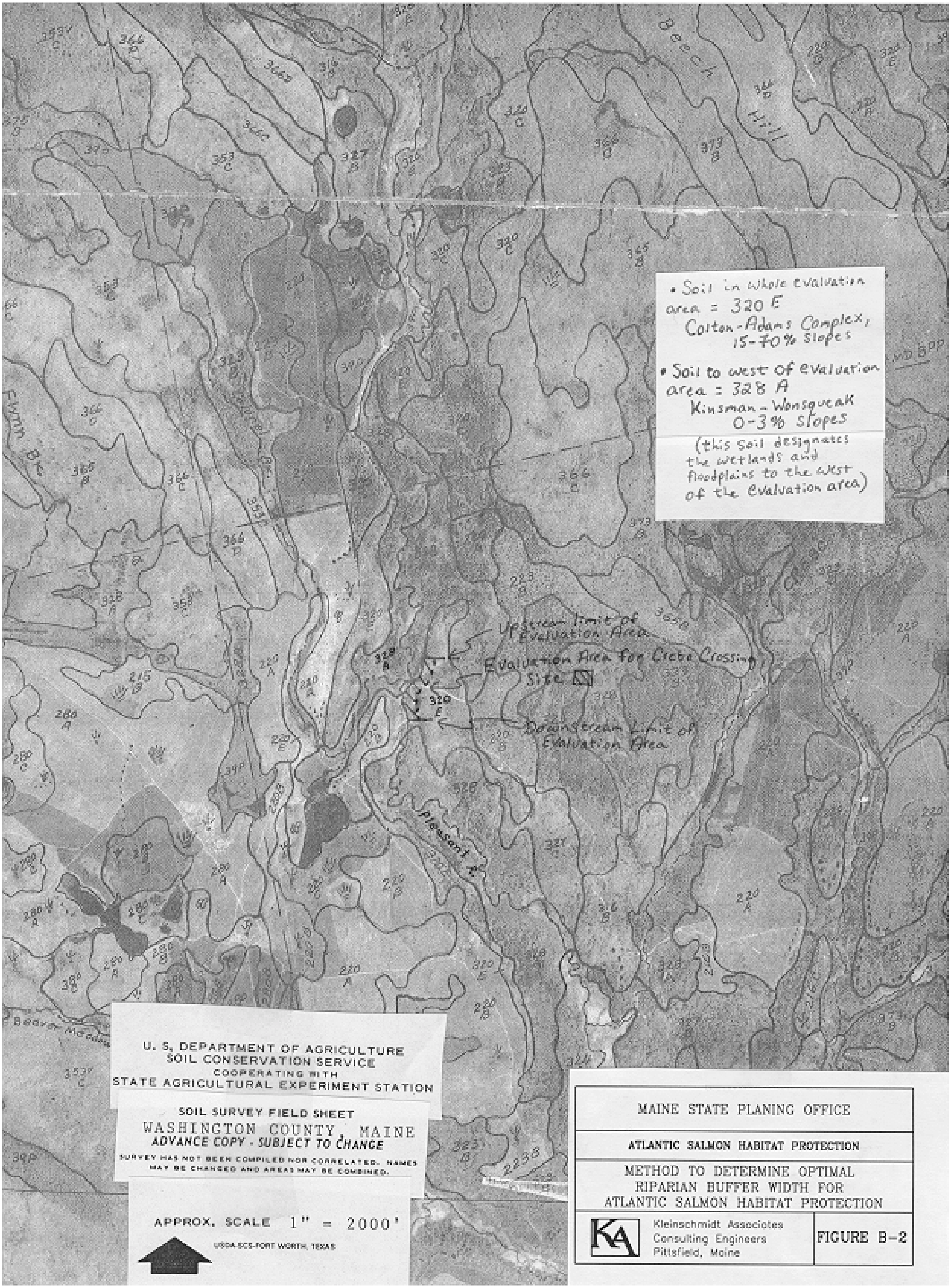
<u>notes</u>

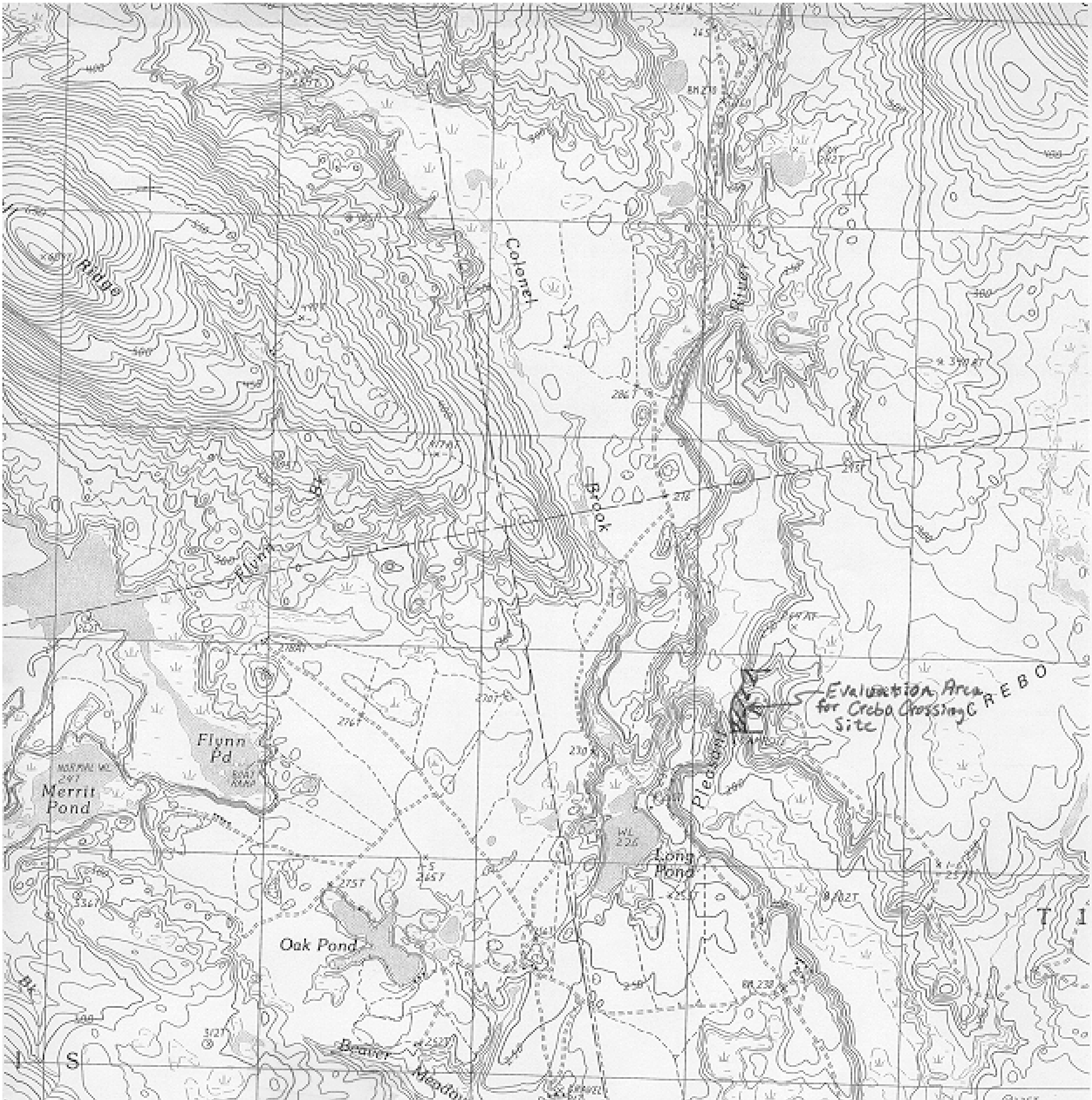
1. The first 35' (closest to stream) of each buffer unit is zone 1.
2. Buffer widths for the shared lines between buffer units are the average of the two adjacent buffer units. For example, the line shared between Buffer Unit #1 and #2 should be 195' (avg of 200' and 190'). The buffer width is equal to the adjacent buffer unit for the lines at the upstream and downstream limits of the evaluation area.
3. Were Buffer Unit #5 the last (upstream-most) unit along a stretch of critical habitat being protected, the optimal buffer width would be extended upstream as shown in Figure 2 of the Method to Determine Optimal Riparian Buffer Width for Atlantic Salmon Habitat Protection. This upstream buffer extension was not sketched-in for this figure since the critical habitat in this evaluation area extends several miles upstream from the area being evaluated (i.e. the buffer evaluation will ideally be continued upstream from this example).

DATE OF PHOTO: 4-26-98
SCALE: 1"= 250' (ENLARGED 3X FROM ORIGINAL 1"= 750' PHOTO)
SITE: CREBO CROSSING (COURTESY OF CHERRYFIELD FOODS)

THIS AERIAL PHOTO WAS DERIVED FORM DATA AND DOCUMENTATION COMMISSIONED BY THE 1998 ICE STORM RECOVERY PROJECT, AN INTERAGENCY PROGRAM LED BY THE MAINE FOREST SERVICE IN COOPERATION WITH THE U.S. FOREST SERVICE. J.W. SEWALL CO.

MAINE STATE PLANING OFFICE	
ATLANTIC SALMON HABITAT PROTECTION	
METHOD TO DETERMINE OPTIMAL RIPARIAN BUFFER WIDTH FOR ATLANTIC SALMON HABITAT PROTECTION	
Kleinschmidt Associates Consulting Engineers Pittsfield, Maine	FIGURE B-1


• Soil in whole evaluation area = 320 E
Colton-Adams Complex, 15-70% slopes
• Soil to west of evaluation area = 328 A
Kinsman-Wonsqueak 0-3% slopes
(this soil designates the wetlands and floodplains to the west of the evaluation area)
Upstream limit of Evaluation Area
Evaluation Area for Crebo Crossing Site
Downstream limit of Evaluation Area
Pleasant R.
Beech Hill
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COOPERATING WITH
STATE AGRICULTURAL EXPERIMENT STATION
SOIL SURVEY FIELD SHEET
WASHINGTON COUNTY, MAINE
ADVANCE COPY - SUBJECT TO CHANGE
SURVEY HAS NOT BEEN COMPILED NOR CORRELATED. NAMES MAY BE CHANGED AND AREAS MAY BE COMBINED.
APPROX. SCALE 1" = 2000'
USDA-SCS-FORT WORTH, TEXAS
MAINE STATE PLANING OFFICE
ATLANTIC SALMON HABITAT PROTECTION
METHOD TO DETERMINE OPTIMAL RIPARIAN BUFFER WIDTH FOR ATLANTIC SALMON HABITAT PROTECTION
KA Kleinschmidt Associates
Consulting Engineers
Pittsfield, Maine
FIGURE B-2



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

NORTHEAST BLUFF QUADRANGLE
MAINE–WASHINGTON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

SCALE 1:24 000

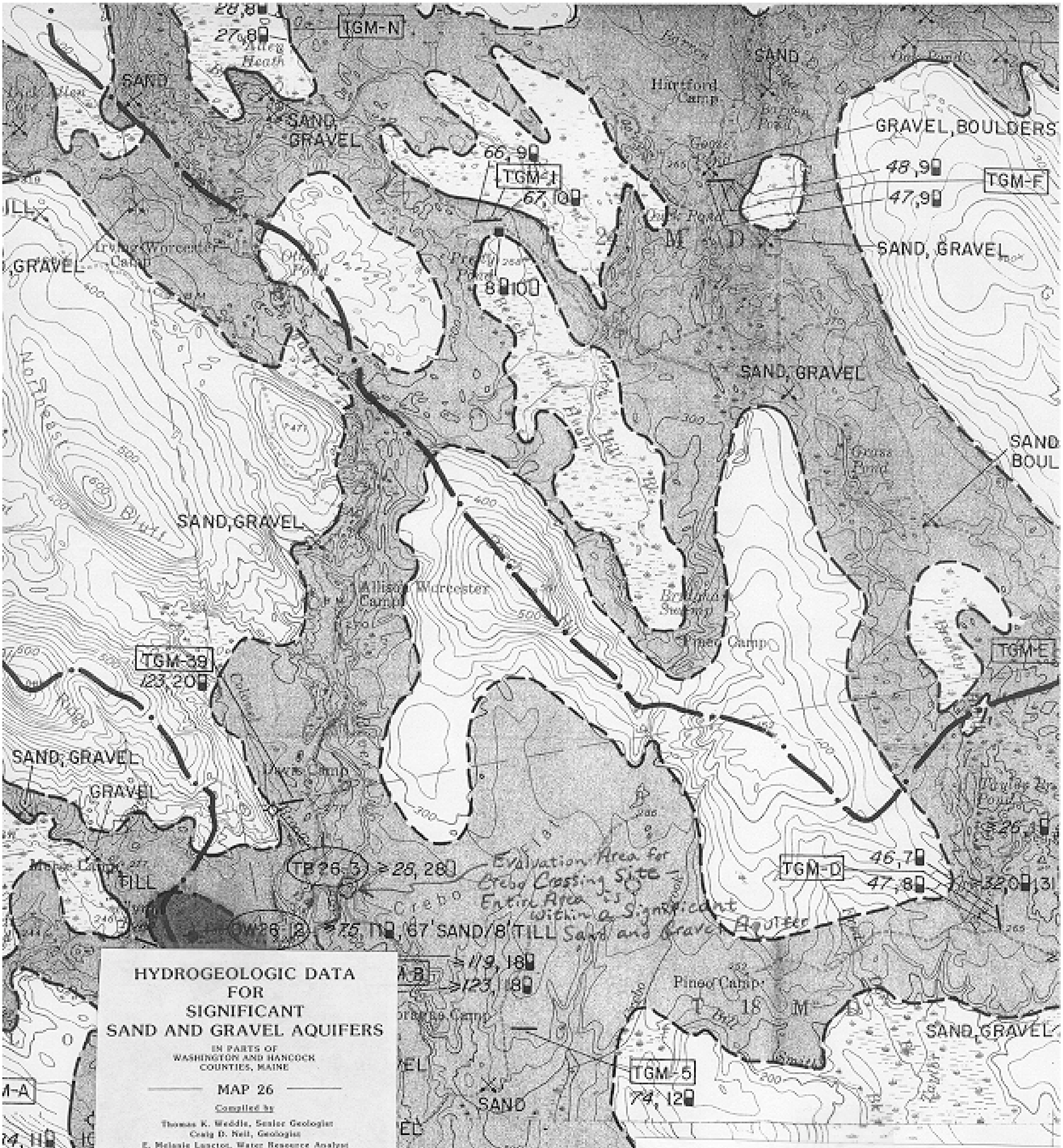
MAINE STATE PLANING OFFICE

ATLANTIC SALMON HABITAT PROTECTION

METHOD TO DETERMINE OPTIMAL
RIPARIAN BUFFER WIDTH FOR
ATLANTIC SALMON HABITAT PROTECTION

KA Kleinschmidt Associates
Consulting Engineers
Pittsfield, Maine

FIGURE B-3



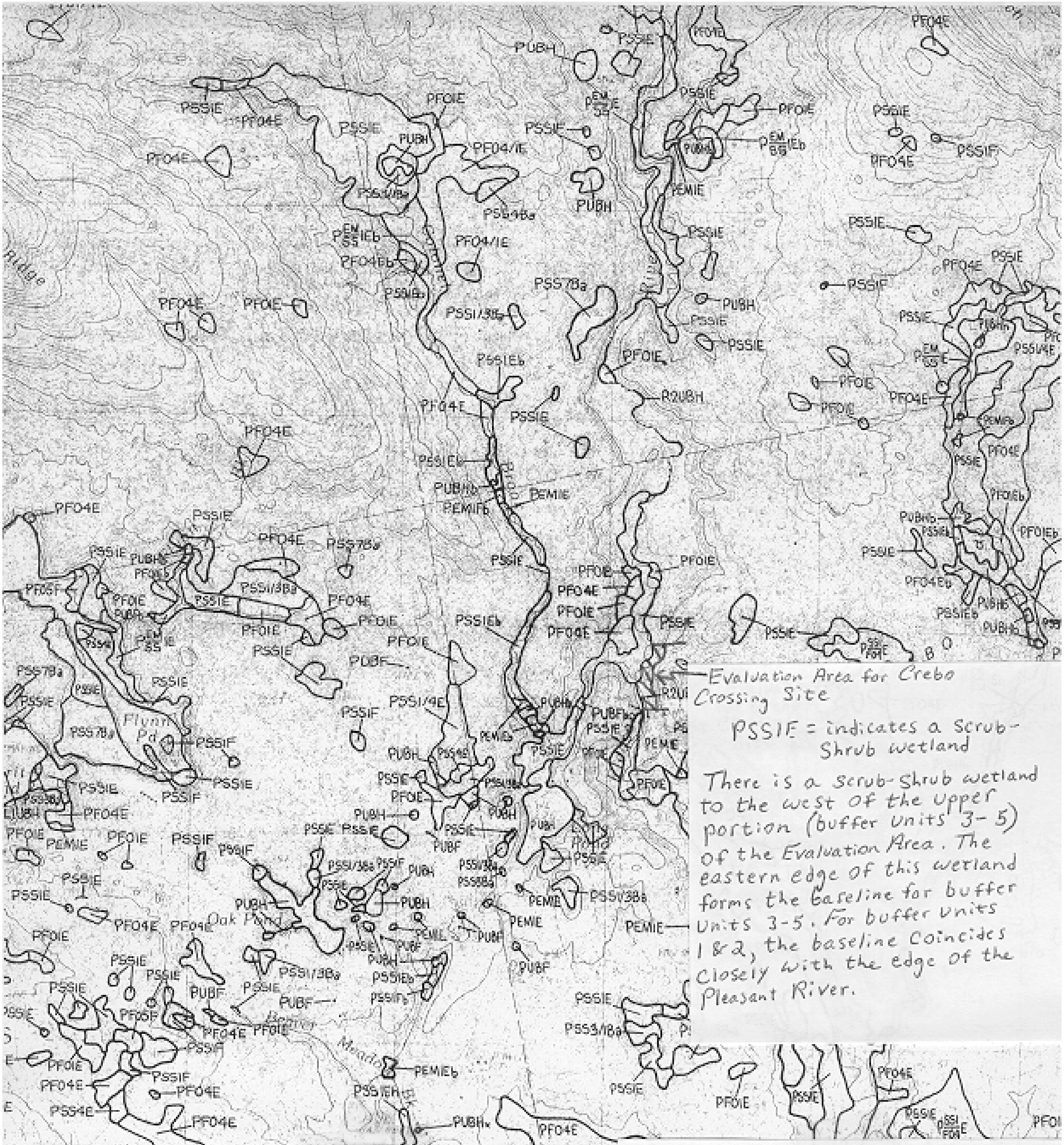
MAINE STATE PLANING OFFICE

ATLANTIC SALMON HABITAT PROTECTION

METHOD TO DETERMINE OPTIMAL RIPARIAN BUFFER WIDTH FOR ATLANTIC SALMON HABITAT PROTECTION

Kleinschmidt Associates Consulting Engineers Pittsfield, Maine

FIGURE B-4



SCALE 1:24 000

U.S. DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

Prepared by National Wetlands Inventory

Base map provided by the United States Geological Survey.

1995

MAINE STATE PLANING OFFICE

DATA SHEET
RIPARIAN BUFFER CHARACTERISTICS
(ATLANTIC SALMON HABITAT PROTECTION)

Date: 12/3/98 **Evaluator(s):** AEH, JDB, GGD, BP

River/Stream: Pleasant River **USGS Quadrangle:** Northeast Bluff

Latitude/longitude (optional if location shown on USGS Quad.): ______

Buffer unit #: 1 **Stream order** (optional): 3rd

Site location (describe): Crebo Crossing - East side of river, immediately north of bridge NOTE: Evaluation conducted on Cherryfield Foods property w/permission from Bill Patrick

Data for Determining Start Point (i.e. Baseline) for Buffers

Floodplains and Adjacent Open Wetlands: Identify the landward edge of all floodplains and open wetlands (i.e. emergent and scrub-shrub wetlands) adjacent to the stream. These features are considered part of the stream zone being protected rather than part of the buffer. Begin buffer measurements at the landward edge of these features. **(check applicable item(s) below)**

Neither floodplains nor open wetlands occur immediately adjacent to the stream ✓
(use the normal high water line of the stream as the baseline for buffer measurement)

Emergent and/or scrub-shrub wetland identified adjacent to stream _____
Floodplain identified adjacent to stream _____
(use the landward edge of these features as the baseline for buffer measurement)

Data for Use With Buffer Width Key (Primary Attributes)

Slope:		**Soils:**	
0-8%	____	hydrologic soils group A	✓
8-15%	____	hydrologic soils group B	____
15-25%	✓	hydrologic soils group C	____
>25%	____	hydrologic soils group D	____

source/calculation method: Soil Survey indicates 15-70%. Narrowed to 15-25% in field by visual estimate/best professional judgement (Consensus of 3 field biologists and an engineer).

source (e.g. County Soil Survey): Soil Survey

% Canopy Closure:

0-25%______ 26-50% ✓ 51-75% ✓ 76-100%____

source/calculation method (e.g. recent aerial photo, field determination): 1998 aerials (Confirmed in field)

DATA SHEET
RIPARIAN BUFFER CHARACTERISTICS
(ATLANTIC SALMON HABITAT PROTECTION)

Date: 12/3/98 **Evaluator(s):** AEH, JDB, GGD, BP

River/Stream: Pleasant River **USGS Quadrangle:** Northeast Bluff

Latitude/longitude (optional if location shown on USGS Quad.): ______

Buffer unit #: 1 **Stream order** (optional): 3rd

Site location (describe): Crebo Crossing - East side of river, immediately north of bridge NOTE: Evaluation conducted on Cherryfield Foods property w/ permission from Bill Patrick

Data for Determining Start Point (i.e. Baseline) for Buffers

Floodplains and Adjacent Open Wetlands: Identify the landward edge of all floodplains and open wetlands (i.e. emergent and scrub-shrub wetlands) adjacent to the stream. These features are considered part of the stream zone being protected rather than part of the buffer. Begin buffer measurements at the landward edge of these features. **(check applicable item(s) below)**

Neither floodplains nor open wetlands occur immediately adjacent to the stream ✓
(use the normal high water line of the stream as the baseline for buffer measurement)

Emergent and/or scrub-shrub wetland identified adjacent to stream _____
Floodplain identified adjacent to stream _____
(use the landward edge of these features as the baseline for buffer measurement)

Data for Use With Buffer Width Key (Primary Attributes)

Slope:
0-8% ____
8-15% ____
15-25% ✓
>25% ____

Soils:
hydrologic soils group A ✓
hydrologic soils group B ____
hydrologic soils group C ____
hydrologic soils group D ____

source/calculation method: Soil Survey indicates 15-70%. Narrowed to 15-25% in field by visual estimate/best professional judgement (Consensus of 3 field biologists and an engineer).

source (e.g. County Soil Survey): Soil Survey

% Canopy Closure:

0-25% ____ 26-50% ✓ 51-75% ✓ 76-100% ____

source/calculation method (e.g. recent aerial photo, field determination): 1998 aerials (Confirmed in field)

Additional Data Used to Adjust Buffer Width (Secondary Attributes)

Surface Water Features: (check all that apply)

no surface water features located in the buffer: ✓

(no adjustment to buffer width)

intermittent stream: _____

perennial stream: _____

ditch or swale: _____

other (e.g. pond connected to river by culvert or outlet stream): _____

(add 50' to zone 2; in addition, maintain a 35' no-harvest strip adjacent to perennial surface water features in zone 2)

Exception: if the surface water feature is not connected to the in-stream habitat being protected by means of surface drainage no adjustment is made (e.g. isolated pond).

Note: surface water features as defined here include the State of Maine (e.g. NRPA regs) definition of river, stream or brook in addition to constructed ditches and swales that carry stormwater drainage to the in-stream habitat being protected.

source (e.g. field work, USGS map, NWI map, aerial photo): All of the above

Note: If surface water features are identified in the field but are not indicated on available map resources, locations should be shown on map.

Groundwater Seepage or Springs: (check one)

Spring(s)/groundwater seepage present in buffer (note # and approx. locations): _______

(add 25' to zone 2)

Springs/groundwater seepage not present in buffer ✓

Could not determine if spring/seepage present or not _____ (in some cases it will not be possible to positively identify springs/groundwater seepage based on field observation)

(no adjustment to buffer width)

Basis: Soils unit (i.e. Colton-Adams) has high potential for aquifers and Stream Valley Springs (See Attach. E), but none found in the field.

Note: A field indicator of springs is relatively constant discharge of cool water (in Maine, usually 4.4 °C to 10.0 °C) to the surface. Typically there is not surface water inflow, yet water trickles/seeps out. Often there is a seepage wetland or small spring-fed stream associated with these groundwater discharge features. Perched or shallow subsurface drainage seeps not directly connected to the underlying aquifer should not be counted (groundwater discharge in areas of highly permeable glacial deposits should be assumed to be connected to the underlying aquifer). Springs/seeps often occur on lower portions of side-slopes adjacent to streams. In Washington County, springs are often associated with highly permeable glacial deposits.

Surface Roughness: (check one)

High degree of surface roughness:_____
(subtract 25' from zone 2)
Typical degree of surface roughness:____
(no adjustment to buffer width)
Low degree of surface roughness: ✓
(add 25' to zone 2)

Note: Refer to Attachment C (surface roughness guidelines). Surface roughness features include:

- coarse woody debris ($\geq$ 2 cm)
- rotten stumps or logs typically covered with moss
- boulders or rocks
- herbaceous vegetation
- pit and mound or undulating topography (complex/rough microtopography); a portion of the land surface slopes away from the stream
- intact duff layer (surface organic horizon)/lack of exposed mineral soils

Buffer has exposed mineral soils (i.e. duff layer not intact) as a result of human activity: ✓
(automatically low degree of surface roughness; add 25' to zone 2)
Buffer does not have exposed mineral soils as a result of human activity: ____
(typical or high degree of surface roughness; no change or subtract 25' – see Attach. C)
If exposed mineral soils, note cause (if known): dirt road bisects buffer parallel to stream about 100' from normal high water mark of stream.

Sand and Gravel Aquifers: (check one)

Mapped Significant Sand and Gravel Aquifer (or any portion of such a feature) occurs in buffer ✓
(add 25' to zone 2)
Mapped Significant Sand and Gravel Aquifer does not occur in buffer ____
(no adjustment to buffer width)

Wetlands: (check all that apply)

Isolated wetland (not connected to stream by surface drainage) occurs in buffer ____
Wetland directly connected to stream by surface drainage occurs in buffer ____
(add 25' to zone 2 for the presence of any wetland area, regardless of whether it is isolated or connected; further expand zone 2 to encompass the entire wetland for any wetland that is at least partly in the buffer and is connected to the stream being protected by means of intermittent or perennial surface flows)

No wetlands located in the buffer ✓
(no adjustment to buffer width)

source (e.g. field work, NWI map): field work and NWI map

Very Steep Slopes (*i.e.* >25%): Note all areas in the buffer that have very steep slopes. **(check one)**

Very steep slopes identified in buffer area ___
(expand zone 2 as necessary to encompass the entire area of very steep slopes)
Very steep slopes not located in buffer area ✓
(no adjustment to buffer width)

Additional Information

Soil Series and Surficial Geology:

Soil Series (from Soil Survey or professional assessment): Colton-Adams complex 15-70%
Surficial geologic material(s) in buffer: Coarse-grained (sandy) glaciomarine/glacial outwash
Note: this data does not result specific additional adjustments to the buffer width but this information may help identify soil characteristics, aspects of water movement through the buffer, and areas sensitive to potential groundwater contamination.

Identifiable Land Uses:

	Type of land use	location/coverage	source (e.g. field work)
1.	Unmanaged forest	majority of buffer	field work + aerials
2.	dirt road	bisects entire buffer	" " "
3.			

Note: *Land uses affect buffer attributes such as % canopy cover, surface roughness, and soil hydrologic group (infiltration capacity). These, in turn, affect optimal buffer width. But additional buffer width adjustments are not made as a result of specific land use practices historically occurring in the buffer. There are recommended land use restrictions in the buffer zone (zone 1 and zone 2), however in many cases it is impractical to eliminate historical uses in these zones. Best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer (e.g. establish woody vegetation).*

Note any differences between actual field conditions and desk-top data collected (field data should generally take precedent over desk-top data):

None

Other Notes:

Although it was 12/3, there was no snow cover, soils were thawed, and all biotic and abiotic buffer characteristics were apparent with the exception of some herbaceous species. Herb cover did not have to be estimated, however, since surface roughness categories were obvious throughout (e.g. areas w/ roads have low degree of surface roughness & areas in woods had high degree regardless of herb cover).

WORKSHEET
BUFFER # 1

1. **Length of buffer unit along baseline/stream *: 200'**

2. **Width of buffer unit used to measure/determine buffer attributes (i.e. not the same as optimal buffer width – use Attachment B): 200'**

3. **Unadjusted buffer width from key: 150'**

4. **Adjust number from the key to account for those factors that result in specific increases or decreases in buffer width:**

Adjustment for surface water features:	—	=	150'
Adjustment for groundwater seepage/springs:	—	=	150'
Adjustment for surface roughness:	+25'	=	175'
Adjustment for signif. sand & gravel aquifers:	+25'	=	200'
Adjustment for wetlands:	—	=	200'

Adjusted Buffer Width: 200'

5. **Finally, expand the buffer width as necessary to include:**
   a. all areas of very steep (i.e. >25%) slopes that are at least partially within the adjusted buffer width (as determined in step 2), and
   b. all wetlands connected to the salmon stream by surface drainage that are at least partially within the adjusted buffer width (as determined in step 2)

   Describe adjustments made, if any, for very steep slopes: NONE

   Describe adjustments made, if any, for connected wetlands: NONE

* The length of buffer units should be no more than 300' along the baseline of the stream reach being protected (the baseline is parallel to the normal high water mark of the stream or, if there are adjacent floodplains or open wetlands, the baseline is parallel to the landward edge of these features). Evaluators should not be constrained by this number, however, and may choose smaller lengths so that breaks between buffer units coincide with logical changes in buffer attributes, such as abrupt changes in slope, soils, % canopy cover, or wetlands.

DATA SHEET
RIPARIAN BUFFER CHARACTERISTICS
(ATLANTIC SALMON HABITAT PROTECTION)

Date: 12/3/98 **Evaluator(s):** AEH, JDB, GGD, BP

River/Stream: Pleasant **USGS Quadrangle:** Northeast Bluff

Latitude/longitude (optional if location shown on USGS Quad.): ____________________

Buffer unit #: 2 **Stream order** (optional): 3rd

Site location
(describe): Crebo Crossing – E side of river, immediately N of Buffer Unit 1

Data for Determining Start Point (i.e. Baseline) for Buffers

Floodplains and Adjacent Open Wetlands: Identify the landward edge of all floodplains and open wetlands (i.e. emergent and scrub-shrub wetlands) adjacent to the stream. These features are considered part of the stream zone being protected rather than part of the buffer. Begin buffer measurements at the landward edge of these features. **(check applicable item(s) below)**

Neither floodplains nor open wetlands occur immediately adjacent to the stream ✓
(use the normal high water line of the stream as the baseline for buffer measurement)

Emergent and/or scrub-shrub wetland identified adjacent to stream _____
Floodplain identified adjacent to stream _____
(use the landward edge of these features as the baseline for buffer measurement)

Data for Use With Buffer Width Key (Primary Attributes)
Note: All data the same as for Buffer Unit 1 except for % Canopy Closure

Slope:
0-8% _____
8-15% _____
15-25% ✓
>25% _____

Soils:
hydrologic soils group A ✓
hydrologic soils group B _____
hydrologic soils group C _____
hydrologic soils group D _____

source/calculation method: See Buffer Unit 1 (#1)

source (*e.g.* County Soil Survey): See #1

% Canopy Closure:

0-25% _____ 26-50% _____ 51-75% ✓ 76-100% _____

source/calculation method (*e.g.* recent aerial photo, field determination): See #1

Additional Data Used to Adjust Buffer Width (Secondary Attributes)

Surface Water Features: (check all that apply)

no surface water features located in the buffer: ✓

(no adjustment to buffer width)

intermittent stream: _____
perennial stream: _____
ditch or swale: _____
other (e.g. pond connected to river by culvert or outlet stream): _____

(add 50' to zone 2; in addition, maintain a 35' no-harvest strip adjacent to perennial surface water features in zone 2)
Exception: if the surface water feature is not connected to the in-stream habitat being protected by means of surface drainage no adjustment is made (e.g. isolated pond).

Note: surface water features as defined here include the State of Maine (e.g. NRPA regs) definition of river, stream or brook in addition to constructed ditches and swales that carry stormwater drainage to the in-stream habitat being protected.

source (*e.g.* field work, USGS map, NWI map, aerial photo): See #1

Note: If surface water features are identified in the field but are not indicated on available map resources, locations should be shown on map.

Groundwater Seepage or Springs: (check one)

Spring(s)/groundwater seepage present in buffer (note # and approx. locations): _______

(add 25' to zone 2)

Springs/groundwater seepage not present in buffer ✓
Could not determine if spring/seepage present or not _____ (in some cases it will not be possible to positively identify springs/groundwater seepage based on field observation)

(no adjustment to buffer width)

Basis: See #1

Note: A field indicator of springs is relatively constant discharge of cool water (in Maine, usually 4.4 °C to 10.0 °C) to the surface. Typically there is not surface water inflow, yet water trickles/seeps out. Often there is a seepage wetland or small spring-fed stream associated with these groundwater discharge features. Perched or shallow subsurface drainage seeps not directly connected to the underlying aquifer should not be counted (groundwater discharge in areas of highly permeable glacial deposits should be assumed to be connected to the underlying aquifer). Springs/seeps often occur on lower portions of side-slopes adjacent to streams. In Washington County, springs are often associated with highly permeable glacial deposits.

Surface Roughness: (check one)

High degree of surface roughness:_____
(subtract 25' from zone 2)
Typical degree of surface roughness:____
(no adjustment to buffer width)
Low degree of surface roughness: ✓ (road in buffer)
(add 25' to zone 2)

Note: Refer to Attachment C (surface roughness guidelines). Surface roughness features include:

- coarse woody debris (≥ 2 cm)
- rotten stumps or logs typically covered with moss
- boulders or rocks
- herbaceous vegetation
- pit and mound or undulating topography (complex/rough microtopography); a portion of the land surface slopes away from the stream
- intact duff layer (surface organic horizon)/lack of exposed mineral soils

Buffer has exposed mineral soils (i.e. duff layer not intact) as a result of human activity: ✓
(automatically low degree of surface roughness; add 25' to zone 2)
Buffer does not have exposed mineral soils as a result of human activity: ____
(typical or high degree of surface roughness; no change or subtract 25' – see Attach. C)
If exposed mineral soils, note cause (if known): See #1

Sand and Gravel Aquifers: (check one)

Mapped Significant Sand and Gravel Aquifer (or any portion of such a feature) occurs in buffer ✓
(add 25' to zone 2)
Mapped Significant Sand and Gravel Aquifer does not occur in buffer ____
(no adjustment to buffer width)

Wetlands: (check all that apply)

Isolated wetland (not connected to stream by surface drainage) occurs in buffer ____
Wetland directly connected to stream by surface drainage occurs in buffer ____
(add 25' to zone 2 for the presence of any wetland area, regardless of whether it is isolated or connected; further expand zone 2 to encompass the entire wetland for any wetland that is at least partly in the buffer and is connected to the stream being protected by means of intermittent or perennial surface flows)

No wetlands located in the buffer ✓
(no adjustment to buffer width)

source (*e.g.* field work, NWI map): See #1

Very Steep Slopes (*i.e.* >25%): Note all areas in the buffer that have very steep slopes. **(check one)**

Very steep slopes identified in buffer area ___
(expand zone 2 as necessary to encompass the entire area of very steep slopes)
Very steep slopes not located in buffer area ✓
(no adjustment to buffer width)

Additional Information

Soil Series and Surficial Geology:

Soil Series (from Soil Survey or professional assessment): Same as Buffer Unit #1
Surficial geologic material(s) in buffer: " " " " "
Note: this data does not result specific additional adjustments to the buffer width but this information may help identify soil characteristics, aspects of water movement through the buffer, and areas sensitive to potential groundwater contamination.

Identifiable Land Uses:

	Type of land use	location/coverage	source (e.g. field work)
1.	SAME AS BUFFER	UNIT #1	
2.			
3.			

Note*: Land uses affect buffer attributes such as % canopy cover, surface roughness, and soil hydrologic group (infiltration capacity). These, in turn, affect optimal buffer width. But additional buffer width adjustments are not made as a result of specific land use practices historically occurring in the buffer. There are recommended land use restrictions in the buffer zone (zone 1 and zone 2), however in many cases it is impractical to eliminate historical uses in these zones. Best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer (e.g. establish woody vegetation).*

Note any differences between actual field conditions and desk-top data collected (field data should generally take precedent over desk-top data):

Other Notes:

Same as Buffer Unit #1

WORKSHEET
BUFFER # 2

1. **Length of buffer unit along baseline/stream *: 2**

2. **Width of buffer unit used to measure/determine buffer attributes (i.e. not the same as optimal buffer width – use Attachment B): 220'**

3. **Unadjusted buffer width from key: 140'**

4. **Adjust number from the key to account for those factors that result in specific increases or decreases in buffer width:**

Adjustment for surface water features:	—	=	140'
Adjustment for groundwater seepage/springs:	—	=	140'
Adjustment for surface roughness:	+25'	=	165'
Adjustment for signif. sand & gravel aquifers:	+25'	=	190'
Adjustment for wetlands:	—	=	190'

Adjusted Buffer Width: 190'

5. **Finally, expand the buffer width as necessary to include:**
   a. all areas of very steep (i.e. >25%) slopes that are at least partially within the adjusted buffer width (as determined in step 2), and
   b. all wetlands connected to the salmon stream by surface drainage that are at least partially within the adjusted buffer width (as determined in step 2)

   Describe adjustments made, if any, for very steep slopes: NONE

   Describe adjustments made, if any, for connected wetlands: NONE

* The length of buffer units should be no more than 300' along the baseline of the stream reach being protected (the baseline is parallel to the normal high water mark of the stream or, if there are adjacent floodplains or open wetlands, the baseline is parallel to the landward edge of these features). Evaluators should not be constrained by this number, however, and may choose smaller lengths so that breaks between buffer units coincide with logical changes in buffer attributes, such as abrupt changes in slope, soils, % canopy cover, or wetlands.

DATA SHEET
RIPARIAN BUFFER CHARACTERISTICS
(ATLANTIC SALMON HABITAT PROTECTION)

Date: 12/3/98 **Evaluator(s):** AEH, JDB, GGD, BP

River/Stream: Pleasant **USGS Quadrangle:** Northeast Bluff

Latitude/longitude (optional if location shown on USGS Quad.): ____________

Buffer unit #: 3 **Stream order** (optional): 3rd

Site location (describe): Crebo Crossing – E Side of river, N of Buffer Unit #2

Data for Determining Start Point (i.e. Baseline) for Buffers

Floodplains and Adjacent Open Wetlands: Identify the landward edge of all floodplains and open wetlands (i.e. emergent and scrub-shrub wetlands) adjacent to the stream. These features are considered part of the stream zone being protected rather than part of the buffer. Begin buffer measurements at the landward edge of these features. **(check applicable item(s) below)**

Neither floodplains nor open wetlands occur immediately adjacent to the stream _____
(use the normal high water line of the stream as the baseline for buffer measurement)

Emergent and/or scrub-shrub wetland identified adjacent to stream ✓
Floodplain identified adjacent to stream ✓
(use the landward edge of these features as the baseline for buffer measurement)

Data for Use With Buffer Width Key (Primary Attributes)

Slope:
- 0-8% ____
- 8-15% ____
- 15-25% ✓
- >25% ____

source/calculation method: See Buffer Unit #1

Soils:
- hydrologic soils group A ✓
- hydrologic soils group B ____
- hydrologic soils group C ____
- hydrologic soils group D ____

source (*e.g.* County Soil Survey): See #1

% Canopy Closure:

0-25% _____ 26-50% _____ 51-75% ✓ 76-100% _____

source/calculation method (*e.g.* recent aerial photo, field determination): See #1

Additional Data Used to Adjust Buffer Width (Secondary Attributes)

Surface Water Features: (check all that apply)

no surface water features located in the buffer: ✓

(no adjustment to buffer width)

intermittent stream: _____

perennial stream: _____

ditch or swale: _____

other (e.g. pond connected to river by culvert or outlet stream): _____

(add 50' to zone 2; in addition, maintain a 35' no-harvest strip adjacent to perennial surface water features in zone 2)

Exception: if the surface water feature is not connected to the in-stream habitat being protected by means of surface drainage no adjustment is made (e.g. isolated pond).

Note: surface water features as defined here include the State of Maine (e.g. NRPA regs) definition of river, stream or brook in addition to constructed ditches and swales that carry stormwater drainage to the in-stream habitat being protected.

source (*e.g.* field work, USGS map, NWI map, aerial photo): See #1

Note: *If surface water features are identified in the field but are not indicated on available map resources, locations should be shown on map.*

Groundwater Seepage or Springs: (check one)

Spring(s)/groundwater seepage present in buffer (note # and approx. locations): ✓

One Spring located in the northwest corner of buffer unit

(add 25' to zone 2)

Springs/groundwater seepage not present in buffer _____

Could not determine if spring/seepage present or not _____ (in some cases it will not be possible to positively identify springs/groundwater seepage based on field observation)

(no adjustment to buffer width)

Basis: Cool water discharging to land Surface – water observed trickling out and no Surface water inputs to Spring at time of visit.

Note: A field indicator of springs is relatively constant discharge of cool water (in Maine, usually 4.4 °C to 10.0 °C) to the surface. Typically there is not surface water inflow, yet water trickles/seeps out. Often there is a seepage wetland or small spring-fed stream associated with these groundwater discharge features. Perched or shallow subsurface drainage seeps not directly connected to the underlying aquifer should not be counted (groundwater discharge in areas of highly permeable glacial deposits should be assumed to be connected to the underlying aquifer). Springs/seeps often occur on lower portions of side-slopes adjacent to streams. In Washington County, springs are often associated with highly permeable glacial deposits.

Surface Roughness: (check one)

High degree of surface roughness:_____
(subtract 25' from zone 2)
Typical degree of surface roughness:____
(no adjustment to buffer width)
Low degree of surface roughness: ✓
(add 25' to zone 2)

Note: Refer to Attachment C (surface roughness guidelines). Surface roughness features include:

- coarse woody debris (≥ 2 cm)
- rotten stumps or logs typically covered with moss
- boulders or rocks
- herbaceous vegetation
- pit and mound or undulating topography (complex/rough microtopography); a portion of the land surface slopes away from the stream
- intact duff layer (surface organic horizon)/lack of exposed mineral soils

Buffer has exposed mineral soils (i.e. duff layer not intact) as a result of human activity: ✓
(automatically low degree of surface roughness; add 25' to zone 2)
Buffer does not have exposed mineral soils as a result of human activity: ____
(typical or high degree of surface roughness; no change or subtract 25'– see Attach. C)
If exposed mineral soils, note cause (if known): ____________
See #1

Sand and Gravel Aquifers: (check one)

Mapped Significant Sand and Gravel Aquifer (or any portion of such a feature) occurs in buffer ✓
(add 25' to zone 2)
Mapped Significant Sand and Gravel Aquifer does not occur in buffer ____
(no adjustment to buffer width)

Wetlands: (check all that apply)

Isolated wetland (not connected to stream by surface drainage) occurs in buffer ____
Wetland directly connected to stream by surface drainage occurs in buffer ____
(add 25' to zone 2 for the presence of any wetland area, regardless of whether it is isolated or connected; further expand zone 2 to encompass the entire wetland for any wetland that is at least partly in the buffer and is connected to the stream being protected by means of intermittent or perennial surface flows)

No wetlands located in the buffer ✓
(no adjustment to buffer width)

source (*e.g.* field work, NWI map): See #1

Very Steep Slopes (*i.e.* >25%): Note all areas in the buffer that have very steep slopes. **(check one)**

Very steep slopes identified in buffer area ___

(expand zone 2 as necessary to encompass the entire area of very steep slopes)

Very steep slopes not located in buffer area ✓

(no adjustment to buffer width)

Additional Information

Soil Series and Surficial Geology:

Soil Series (from Soil Survey or professional assessment): See #1

Surficial geologic material(s) in buffer: " "

Note: this data does not result specific additional adjustments to the buffer width but this information may help identify soil characteristics, aspects of water movement through the buffer, and areas sensitive to potential groundwater contamination.

Identifiable Land Uses:

	Type of land use	location/coverage	source (e.g. field work)
1.	SEE #1		
2.			
3.			

Note: *Land uses affect buffer attributes such as % canopy cover, surface roughness, and soil hydrologic group (infiltration capacity). These, in turn, affect optimal buffer width. But additional buffer width adjustments are not made as a result of specific land use practices historically occurring in the buffer. There are recommended land use restrictions in the buffer zone (zone 1 and zone 2), however in many cases it is impractical to eliminate historical uses in these zones. Best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer (e.g. establish woody vegetation).*

Note any differences between actual field conditions and desk-top data collected (field data should generally take precedent over desk-top data):

Other Notes:

See #1

WORKSHEET
BUFFER # 3

1. **Length of buffer unit along baseline/stream *: 300'**

2. **Width of buffer unit used to measure/determine buffer attributes (i.e. not the same as optimal buffer width – use Attachment B): 200'**

3. **Unadjusted buffer width from key: 140'**

4. **Adjust number from the key to account for those factors that result in specific increases or decreases in buffer width:**

Adjustment for surface water features:	–	=	140'
Adjustment for groundwater seepage/springs:	+25'	=	165'
Adjustment for surface roughness:	+25'	=	190'
Adjustment for signif. sand & gravel aquifers:	+25'	=	215'
Adjustment for wetlands:	–	=	215'

Adjusted Buffer Width: 215'

5. **Finally, expand the buffer width as necessary to include:**
   a. all areas of very steep (i.e. >25%) slopes that are at least partially within the adjusted buffer width (as determined in step 2), and
   b. all wetlands connected to the salmon stream by surface drainage that are at least partially within the adjusted buffer width (as determined in step 2)

Describe adjustments made, if any, for very steep slopes: None

Describe adjustments made, if any, for connected wetlands: None

* The length of buffer units should be no more than 300' along the baseline of the stream reach being protected (the baseline is parallel to the normal high water mark of the stream or, if there are adjacent floodplains or open wetlands, the baseline is parallel to the landward edge of these features). Evaluators should not be constrained by this number, however, and may choose smaller lengths so that breaks between buffer units coincide with logical changes in buffer attributes, such as abrupt changes in slope, soils, % canopy cover, or wetlands.

DATA SHEET
RIPARIAN BUFFER CHARACTERISTICS
(ATLANTIC SALMON HABITAT PROTECTION)

Date: 12/3/95 **Evaluator(s):** AEH, JDP, GGD, BP

River/Stream: Pleasant **USGS Quadrangle:** Northeast Bluff

Latitude/longitude (optional if location shown on USGS Quad.): ____________

Buffer unit #: 4 **Stream order** (optional): 3rd

Site location
(describe): Crebo Crossing – immediately N of Buffer Unit #3.

Data for Determining Start Point (i.e. Baseline) for Buffers

Floodplains and Adjacent Open Wetlands: Identify the landward edge of all floodplains and open wetlands (i.e. emergent and scrub-shrub wetlands) adjacent to the stream. These features are considered part of the stream zone being protected rather than part of the buffer. Begin buffer measurements at the landward edge of these features. **(check applicable item(s) below)**

Neither floodplains nor open wetlands occur immediately adjacent to the stream ____
(use the normal high water line of the stream as the baseline for buffer measurement)

Emergent and/or scrub-shrub wetland identified adjacent to stream ✓
Floodplain identified adjacent to stream ✓
(use the landward edge of these features as the baseline for buffer measurement)

Data for Use With Buffer Width Key (Primary Attributes)

Slope:
- 0-8% ____
- 8-15% ____
- 15-25% ✓
- >25% ____

source/calculation method: See #1

Soils:
- hydrologic soils group A ✓
- hydrologic soils group B ____
- hydrologic soils group C ____
- hydrologic soils group D ____

source (*e.g.* County Soil Survey): See #1

% Canopy Closure:

0-25% ____ 26-50% ____ 51-75% ____ 76-100% ✓

source/calculation method (*e.g.* recent aerial photo, field determination): See #1

Additional Data Used to Adjust Buffer Width (Secondary Attributes)

Surface Water Features: (check all that apply)

no surface water features located in the buffer: ✓

(no adjustment to buffer width)

intermittent stream: _____

perennial stream: _____

ditch or swale: _____

other (e.g. pond connected to river by culvert or outlet stream): _____

(add 50' to zone 2; in addition, maintain a 35' no-harvest strip adjacent to perennial surface water features in zone 2)

Exception: if the surface water feature is not connected to the in-stream habitat being protected by means of surface drainage no adjustment is made (e.g. isolated pond).

Note: surface water features as defined here include the State of Maine (e.g. NRPA regs) definition of river, stream or brook in addition to constructed ditches and swales that carry stormwater drainage to the in-stream habitat being protected.

source (*e.g.* field work, USGS map, NWI map, aerial photo): See #1

Note: If surface water features are identified in the field but are not indicated on available map resources, locations should be shown on map.

Groundwater Seepage or Springs: (check one)

Spring(s)/groundwater seepage present in buffer (note # and approx. locations): _______

(add 25' to zone 2)

Springs/groundwater seepage not present in buffer ✓

Could not determine if spring/seepage present or not _____ (in some cases it will not be possible to positively identify springs/groundwater seepage based on field observation)

(no adjustment to buffer width)

Basis: See #1

Note: A field indicator of springs is relatively constant discharge of cool water (in Maine, usually 4.4 °C to 10.0 °C) to the surface. Typically there is not surface water inflow, yet water trickles/seeps out. Often there is a seepage wetland or small spring-fed stream associated with these groundwater discharge features. Perched or shallow subsurface drainage seeps not directly connected to the underlying aquifer should not be counted (groundwater discharge in areas of highly permeable glacial deposits should be assumed to be connected to the underlying aquifer). Springs/seeps often occur on lower portions of side-slopes adjacent to streams. In Washington County, springs are often associated with highly permeable glacial deposits.

Surface Roughness: (check one)

High degree of surface roughness: ✓
(subtract 25' from zone 2)
Typical degree of surface roughness:____
(no adjustment to buffer width)
Low degree of surface roughness: _____
(add 25' to zone 2)

Note: Refer to Attachment C (surface roughness guidelines). Surface roughness features include:

- coarse woody debris (≥ 2 cm)
- rotten stumps or logs typically covered with moss
- boulders or rocks
- herbaceous vegetation
- pit and mound or undulating topography (complex/rough microtopography); a portion of the land surface slopes away from the stream
- intact duff layer (surface organic horizon)/lack of exposed mineral soils

Buffer has exposed mineral soils (i.e. duff layer not intact) as a result of human activity: ____
(automatically low degree of surface roughness; add 25' to zone 2)
Buffer does not have exposed mineral soils as a result of human activity: ✓
(typical or high degree of surface roughness; no change or subtract 25' – see Attach. C)
If exposed mineral soils, note cause (if known): ______________________________

Sand and Gravel Aquifers: (check one)

Mapped Significant Sand and Gravel Aquifer (or any portion of such a feature) occurs in buffer ✓
(add 25' to zone 2)
Mapped Significant Sand and Gravel Aquifer does not occur in buffer ____
(no adjustment to buffer width)

Wetlands: (check all that apply)

Isolated wetland (not connected to stream by surface drainage) occurs in buffer ____
Wetland directly connected to stream by surface drainage occurs in buffer ____
(add 25' to zone 2 for the presence of any wetland area, regardless of whether it is isolated or connected; further expand zone 2 to encompass the entire wetland for any wetland that is at least partly in the buffer and is connected to the stream being protected by means of intermittent or perennial surface flows)

No wetlands located in the buffer ✓
(no adjustment to buffer width)

source (*e.g.* field work, NWI map): ______________________________

Very Steep Slopes (*i.e.* >25%): Note all areas in the buffer that have very steep slopes. **(check one)**

Very steep slopes identified in buffer area ___

(expand zone 2 as necessary to encompass the entire area of very steep slopes)

Very steep slopes not located in buffer area ✓

(no adjustment to buffer width)

Additional Information

Soil Series and Surficial Geology:

Soil Series (from Soil Survey or professional assessment): See #1

Surficial geologic material(s) in buffer: " "

Note: this data does not result specific additional adjustments to the buffer width but this information may help identify soil characteristics, aspects of water movement through the buffer, and areas sensitive to potential groundwater contamination.

Identifiable Land Uses:

	Type of land use	location/coverage	source (e.g. field work)
1.	See #1		
2.			
3.			

Note: *Land uses affect buffer attributes such as % canopy cover, surface roughness, and soil hydrologic group (infiltration capacity). These, in turn, affect optimal buffer width. But additional buffer width adjustments are not made as a result of specific land use practices historically occurring in the buffer. There are recommended land use restrictions in the buffer zone (zone 1 and zone 2), however in many cases it is impractical to eliminate historical uses in these zones. Best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer (e.g. establish woody vegetation).*

Note any differences between actual field conditions and desk-top data collected (field data should generally take precedent over desk-top data)**:**

Other Notes:

See #1.

WORKSHEET
BUFFER # 4

1. **Length of buffer unit along baseline/stream *: 190'**

2. **Width of buffer unit used to measure/determine buffer attributes (i.e. not the same as optimal buffer width – use Attachment B): 200'**

3. **Unadjusted buffer width from key: 130'**

4. **Adjust number from the key to account for those factors that result in specific increases or decreases in buffer width:**

Adjustment for surface water features:	–	=	130'
Adjustment for groundwater seepage/springs:	–	=	130'
Adjustment for surface roughness:	-25'	=	105'
Adjustment for signif. sand & gravel aquifers:	+25'	=	130'
Adjustment for wetlands:	–	=	130'

Adjusted Buffer Width: 130'

5. **Finally, expand the buffer width as necessary to include:**
   a. all areas of very steep (i.e. >25%) slopes that are at least partially within the adjusted buffer width (as determined in step 2), and
   b. all wetlands connected to the salmon stream by surface drainage that are at least partially within the adjusted buffer width (as determined in step 2)

   Describe adjustments made, if any, for very steep slopes: NONE

   Describe adjustments made, if any, for connected wetlands: NONE

* The length of buffer units should be no more than 300' along the baseline of the stream reach being protected (the baseline is parallel to the normal high water mark of the stream or, if there are adjacent floodplains or open wetlands, the baseline is parallel to the landward edge of these features). Evaluators should not be constrained by this number, however, and may choose smaller lengths so that breaks between buffer units coincide with logical changes in buffer attributes, such as abrupt changes in slope, soils, % canopy cover, or wetlands.

DATA SHEET
RIPARIAN BUFFER CHARACTERISTICS
(ATLANTIC SALMON HABITAT PROTECTION)

Date: 12/3/98 **Evaluator(s):** AEH, JDB, GGD, BP

River/Stream: Pleasant **USGS Quadrangle:** Northeast Bluff

Latitude/longitude (optional if location shown on USGS Quad.): ____

Buffer unit #: 5 **Stream order** (optional): 3rd

Site location (describe): Creba Crossing – immediately N. of Buffer Unit #4

Data for Determining Start Point (i.e. Baseline) for Buffers

Floodplains and Adjacent Open Wetlands: Identify the landward edge of all floodplains and open wetlands (i.e. emergent and scrub-shrub wetlands) adjacent to the stream. These features are considered part of the stream zone being protected rather than part of the buffer. Begin buffer measurements at the landward edge of these features. **(check applicable item(s) below)**

Neither floodplains nor open wetlands occur immediately adjacent to the stream ____
(use the normal high water line of the stream as the baseline for buffer measurement)

Emergent and/or scrub-shrub wetland identified adjacent to stream ✓
Floodplain identified adjacent to stream ✓
(use the landward edge of these features as the baseline for buffer measurement)

Data for Use With Buffer Width Key (Primary Attributes)

Slope:
- 0-8% ____
- 8-15% ✓
- 15-25% ✓
- >25% ____

Soils:
- hydrologic soils group A ✓
- hydrologic soils group B ____
- hydrologic soils group C ____
- hydrologic soils group D ____

source/calculation method: See #1

source (*e.g.* County Soil Survey): See #1

% Canopy Closure:

0-25% ____ 26-50% ____ 51-75% ____ 76-100% ✓

source/calculation method (*e.g.* recent aerial photo, field determination): 100% between 0-155', 0% between 155-200' = 78% (using aerial + field confirmation)

Additional Data Used to Adjust Buffer Width (Secondary Attributes)

Surface Water Features: (check all that apply)

no surface water features located in the buffer: ✓

(no adjustment to buffer width)

intermittent stream: _____

perennial stream: _____

ditch or swale: _____

other (e.g. pond connected to river by culvert or outlet stream): _____

(add 50' to zone 2; in addition, maintain a 35' no-harvest strip adjacent to perennial surface water features in zone 2)

Exception: if the surface water feature is not connected to the in-stream habitat being protected by means of surface drainage no adjustment is made (e.g. isolated pond).

Note: surface water features as defined here include the State of Maine (e.g. NRPA regs) definition of river, stream or brook in addition to constructed ditches and swales that carry stormwater drainage to the in-stream habitat being protected.

source (e.g. field work, USGS map, NWI map, aerial photo): See #1

Note: If surface water features are identified in the field but are not indicated on available map resources, locations should be shown on map.

Groundwater Seepage or Springs: (check one)

Spring(s)/groundwater seepage present in buffer (note # and approx. locations): _____

(add 25' to zone 2)

Springs/groundwater seepage not present in buffer ✓

Could not determine if spring/seepage present or not _____ (in some cases it will not be possible to positively identify springs/groundwater seepage based on field observation)

(no adjustment to buffer width)

Basis: See #1

Note: A field indicator of springs is relatively constant discharge of cool water (in Maine, usually 4.4 °C to 10.0 °C) to the surface. Typically there is not surface water inflow, yet water trickles/seeps out. Often there is a seepage wetland or small spring-fed stream associated with these groundwater discharge features. Perched or shallow subsurface drainage seeps not directly connected to the underlying aquifer should not be counted (groundwater discharge in areas of highly permeable glacial deposits should be assumed to be connected to the underlying aquifer). Springs/seeps often occur on lower portions of side-slopes adjacent to streams. In Washington County, springs are often associated with highly permeable glacial deposits.

Surface Roughness: (check one)

High degree of surface roughness:_____
(subtract 25' from zone 2)
Typical degree of surface roughness: ✓ (high degree between 0-155', low degree between 155-200')
(no adjustment to buffer width)
Low degree of surface roughness: _____
(add 25' to zone 2)

Note: Refer to Attachment C (surface roughness guidelines). Surface roughness features include:

- coarse woody debris (≥ 2 cm)
- rotten stumps or logs typically covered with moss
- boulders or rocks
- herbaceous vegetation
- pit and mound or undulating topography (complex/rough microtopography); a portion of the land surface slopes away from the stream
- intact duff layer (surface organic horizon)/lack of exposed mineral soils

Buffer has exposed mineral soils (i.e. duff layer not intact) as a result of human activity: ____
(automatically low degree of surface roughness; add 25' to zone 2)
Buffer does not have exposed mineral soils as a result of human activity: ✓
(typical or high degree of surface roughness; no change or subtract 25' – see Attach. C)
If exposed mineral soils, note cause (if known): ______________________________

Sand and Gravel Aquifers: (check one)

Mapped Significant Sand and Gravel Aquifer (or any portion of such a feature) occurs in buffer ✓
(add 25' to zone 2)
Mapped Significant Sand and Gravel Aquifer does not occur in buffer ____
(no adjustment to buffer width)

Wetlands: (check all that apply)

Isolated wetland (not connected to stream by surface drainage) occurs in buffer ____
Wetland directly connected to stream by surface drainage occurs in buffer ____
(add 25' to zone 2 for the presence of any wetland area, regardless of whether it is isolated or connected; further expand zone 2 to encompass the entire wetland for any wetland that is at least partly in the buffer and is connected to the stream being protected by means of intermittent or perennial surface flows)

No wetlands located in the buffer ✓
(no adjustment to buffer width)

source (*e.g.* field work, NWI map): ______________________________

Very Steep Slopes (*i.e.* >25%): Note all areas in the buffer that have very steep slopes. **(check one)**

Very steep slopes identified in buffer area ___
(expand zone 2 as necessary to encompass the entire area of very steep slopes)
Very steep slopes not located in buffer area ✓
(no adjustment to buffer width)

Additional Information

Soil Series and Surficial Geology:

Soil Series (from Soil Survey or professional assessment): See #1
Surficial geologic material(s) in buffer: " "

Note: this data does not result specific additional adjustments to the buffer width but this information may help identify soil characteristics, aspects of water movement through the buffer, and areas sensitive to potential groundwater contamination.

Identifiable Land Uses:

	Type of land use	location/coverage	source (e.g. field work)
1.	Unmanaged forest	between 0-155'	field + aerial
2.	Managed blueberry barren	" 155-200'	" "
3.			

Note: *Land uses affect buffer attributes such as % canopy cover, surface roughness, and soil hydrologic group (infiltration capacity). These, in turn, affect optimal buffer width. But additional buffer width adjustments are not made as a result of specific land use practices historically occurring in the buffer. There are recommended land use restrictions in the buffer zone (zone 1 and zone 2), however in many cases it is impractical to eliminate historical uses in these zones. Best management practices to protect soils and water quality and provide shading should be employed to the maximum extent possible within the two zones of the buffer (e.g. establish woody vegetation).*

Note any differences between actual field conditions and desk-top data collected (field data should generally take precedent over desk-top data):

Other Notes:

See #1

WORKSHEET
BUFFER # 5

1. **Length of buffer unit along baseline/stream *: 220'**

2. **Width of buffer unit used to measure/determine buffer attributes (i.e. not the same as optimal buffer width – use Attachment B): 200'**

3. **Unadjusted buffer width from key: 130'**

4. **Adjust number from the key to account for those factors that result in specific increases or decreases in buffer width:**

Adjustment for surface water features:	–	=	130'
Adjustment for groundwater seepage/springs:	–	=	130'
Adjustment for surface roughness:	–	=	130'
Adjustment for signif. sand & gravel aquifers:	+25'	=	155'
Adjustment for wetlands:	–	=	155'

Adjusted Buffer Width: 155'

5. **Finally, expand the buffer width as necessary to include:**
   a. all areas of very steep (i.e. >25%) slopes that are at least partially within the adjusted buffer width (as determined in step 2), and
   b. all wetlands connected to the salmon stream by surface drainage that are at least partially within the adjusted buffer width (as determined in step 2)

Describe adjustments made, if any, for very steep slopes: NONE

Describe adjustments made, if any, for connected wetlands: NONE

* The length of buffer units should be no more than 300' along the baseline of the stream reach being protected (the baseline is parallel to the normal high water mark of the stream or, if there are adjacent floodplains or open wetlands, the baseline is parallel to the landward edge of these features). Evaluators should not be constrained by this number, however, and may choose smaller lengths so that breaks between buffer units coincide with logical changes in buffer attributes, such as abrupt changes in slope, soils, % canopy cover, or wetlands.

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APPENDIX C

SCIENCE-BASE FOR METHOD

APPENDIX C

SCIENCE-BASE FOR METHOD

1.0 OVERVIEW

The establishment of riparian buffer strips adjacent to areas of critical Atlantic salmon habitat has been identified as one of the most important aspects of conserving native runs of this species (Moring and Finlayson, 1996). The question of specific buffer widths necessary to maintain the ecological integrity of the in-stream habitat is discussed below, along with various background considerations used in the development of this methodology.

2.0 DOWNEAST MAINE-SPECIFIC CONDITIONS

Five of the seven major native Atlantic Salmon rivers in Maine are located in Washington County and extreme eastern Hancock County. This region of Maine is characterized by gentle topography and a predominance of shallow-rooted conifers. The surficial geology of the region is complex. Glacial till, both coarse-textured and fine-textured glaciomarine deposits, ice-contact glaciofluvial deposits (*e.g.* kames and eskers), end moraines, glacial outwash and organic or swamp deposits are intermingled throughout the region and are the dominant parent materials for the soils which have developed here. Relative to most other regions of the glaciated northeast, this region contains a predominance of glacial meltwater-sorted sand and gravel deposits. Dominant land uses in the sparsely populated Washington and extreme eastern Hancock County region include commercial timber lands and blueberry and cranberry production.

Two of the seven rivers are located further down the coast in Lincoln, Kennebec and Waldo Counties. This region is characterized by a more rugged, bedrock-controlled topography, including areas with slopes in excess of 25%. Hardwoods are more numerous, although shallow-rooted conifers are also an important component of the forest in this region. The dominant surficial materials are glacial tills and fine-textured glaciomarine deposits. Many of the soils are shallow-to-bedrock, and glacial meltwater-sorted sand and gravel deposits are not as common as in Washington County, although they are present. The two mid-coast rivers are bordered by a more populated (although still rural) region characterized by a more complicated land use mosaic including residential and agricultural uses.

The Method to Determine Optimal Buffer Width has attempted to take these regional characteristics into account. The increased potential for nutrients and chemicals to reach the in-stream habitat via groundwater flows where sand and gravel deposits are found is taken into consideration by adjusting the optimal buffer width to account for the presence of significant sand and gravel aquifer areas and groundwater discharge or spring occurrences. Restrictions on tree removal in Zone 2 are designed to take into account the fact that shallow-rooted conifer dominated systems may be more susceptible to wind-throw. The wide range of slopes found in the region is accommodated by the buffer width key which considers slopes ranging from gentle to very steep.

3.0 ATLANTIC SALMON HABITAT REQUIREMENTS

Atlantic salmon require specific habitat conditions that are unique to each lifestage. Macrohabitat requirements include large-scale physical influences on habitat use, such as overall water quality, temperature, dissolved oxygen, channel stability, *etc*. that may influence the ability of the species to successfully inhabit a stream or stream reach. Microhabitat requirements include localized parameters such as water depth, velocity, substrate, and cover type and availability. These parameters dictate the specific location and extent within a stream reach that suitable habitat conditions for a given life stage exist.

Habitat Suitability criteria for lifestages of Atlantic salmon have evolved from the work of biologists for a variety of impact assessment and habitat management purposes (USDOI 1994; Moring and Finlayson, 1996). Most criteria have been developed by scientists by correlating the presence or absence of the species and lifestage to a specific set of measured physical conditions, based on field observations made on rivers and streams primarily in Maine and Atlantic Canada. These criteria serve as the knowledge-base of the physical in-stream habitat conditions necessary for each lifestage of salmon to exist, and, therefore, point to the specific riparian buffer functions (listed above) important for the conservation of critical in-stream Atlantic salmon habitat.

Naturally vegetated riparian areas are an important aspect of Atlantic salmon habitat. Disturbance that significantly alters riparian buffer areas adjacent to salmon streams can result in degradation of critical habitat. Cool, well-oxygenated water maintained by canopy shading is an important aspect of salmon habitat. Because salmon lay their eggs in gravel nests (also called Redds) in areas exposed to swiftly flowing waters, any land use which results in sedimentation can fill-in gravel beds, eliminating suitable breeding substrate, and smothering salmon eggs as well as the many invertebrate prey species that inhabit the interstices between gravel. Increased turbidity resulting from higher than normal rates of erosion and sedimentation can also injure the gills of salmon in all life stages and limit foraging success since this species hunts by sight. Trees and coarse woody debris inputs to salmon streams help create and maintain habitat for invertebrate prey items. Such woody debris inputs also help to create pools and riffles (by influencing flow patterns) and provide structural habitat components important for salmon.

4.0 BUFFER FUNCTIONS IMPORTANT FOR ATLANTIC SALMON HABITAT PROTECTION

Buffer functions that are important with respect to Atlantic salmon habitat protection, as identified in the literature, are:

- Shading and temperature regulation. Canopy cover helps maintain cool temperatures during late summer and also lessens temperature decreases related to radiation cooling in the winter.

- Regulation of streamflows by attenuating peak flows and maintaining base flows through the slow release of runoff.

- Water quality protection by filtering sediment and pollutants from upslope areas and stabilizing stream banks.

- Provision of coarse woody debris and other organic matter inputs for salmon habitat structure/cover as well as a base food base for aquatic macro-invertebrates.

Key References: (Hewlett and Fortson, 1982; Bryant, 1983; Davies and Sowles, 1984; Lisle, 1986; Phillips, 1989a and 1989b; US ACOE, 1991; Welsch, 1991; Ohio EPA, 1994; Chase et al., 1995 (revised 1997); Chesapeake Bay Program, 1995; Kahl, 1996; Mitchell, 1996; Moring and Finlayson, 1996; Spence et al, 1996; Chesapeake Bay Program, 1997; USDA Forest Service, 1998 (in press))

5.0 PHYSICAL BUFFER CHARACTERISTICS AFFECTING BUFFER FUNCTION

5.1 Topography

- **Slope** (the greater the slope the wider the optimal buffer),

- **Surface roughness** (slopes which grade steadily and smoothly towards the watercoarse require a greater buffer than topographically complex buffers with pit and mound topography, a high degree of dead-and-down wood, or other surface roughness factors that encourage infiltration and discourage direct surface runoff to the river).

Slope and microtopographic characteristics are important with respect to their strong relationship to erosion and sedimentation potential and other water quality functions such as retention or conversion of nutrients and chemical pollutants (Phillips, 1989a and 1989b; US ACOE, 1991; Welsch, 1991; Ohio EPA, 1994; Chase et al., 1995 (revised 1997); Chesapeake Bay Program, 1995; Spence et al, 1996; Mitchell, 1996; Kahl, 1996; Correll, 1997; Chesapeake Bay Program, 1997; USDA Forest Service, 1998 (in press)).

5.2 Vegetation

- **Percent canopy closure** (the less the canopy closure, the wider the optimal buffer),

- **Ground vegetation and duff layer** (sparse and/or disturbed ground covers and duff layers require wider optimal buffers than would well developed/intact forest floors).

Wooded buffers with a high degree of canopy closure, intact duff layers, and well developed shrub and herb strata generally provide greater uptake of runoff and associated pollutants than do non-forested systems or systems which have been selectively cut or disturbed (ME DEP, 1992; Chesapeake Bay Program, 1995; Spence et al, 1996; Mitchell, 1996; Kahl, 1996; Correll, 1997). Note that ground vegetation and duff layer are factors that were incorporated into the "surface roughness" attribute for this method (*i.e.*, these factors were not incorporated as separate attributes in this method).

Optimal shading and temperature regulation is associated with mature forest cover with a high degree of canopy closure near the stream (Hewlett and Fortson, 1982; ACOE, 1991; Welsch, 1991; Spence et al, 1996; Kahl, 1996; Correll, 1997).

Intact forested riparian areas also provide organic debris inputs which indirectly enhance salmon habitat since wood and leaves provide food and habitat for aquatic organisms and directly enhance salmon habitat through the provision of in-stream structural habitat characteristics from fallen tree and coarse woody debris input (Dolloff, 1998). Woody debris inputs also promote "hydraulic heterogeneity" by creating pools, runs, etc. (Ohio EPA, 1994). Coarse woody debris inputs also provide a mechanism for increasing buffer zone surface roughness in terrestrial areas and provide an energy source for denitrification, thereby preventing concentrated surface runoff patterns and enhancing the ability of the buffer to perform optimal water quality maintenance functions (Correll, 1997).

5.3 Soils and Surficial Geology

- **Soils**, as determined by USDA NRCS soils mapping and definitions (hydrologic group D soils have the highest runoff potential and very low infiltration capacity and require greater buffer widths for optimal function; hydrologic group A and B soils have low runoff potential and high infiltration capacity and require narrower buffer widths; hydrologic group C soils fall in between).

- **Sand and gravel deposits** can allow nutrients and other contaminants to enter the groundwater more easily than would be possible with less coarse-textured soils/surficial deposits. Polluted groundwater can, in turn, impact stream water quality (wider buffers needed for sand and gravel deposits).

In general, the greater the infiltration capacity of the soils (*e.g.* hydrologic groups A and B), the greater the ability of the buffer to perform water quality and water quantity functions (Welsch, 1991; Westchester County Soil and Water Conservation District, 1994). Soils with a high infiltration capacity discourage concentrated, erosive flows, thereby reducing sedimentation inputs and potentially also reducing sediment-bound nutrient (*e.g.* phosphorous) inputs to streams. Such soils are also well suited to providing a flow de-synchronization function.

However, a caveat to the benefits of infiltration capacity is that some types of soils are so highly permeable they can be leaky with regard to nutrient (especially nitrogen) and chemical pollutants (Chesapeake Bay Program, 1995; Grantham, 1996; Speirman et al, 1997; U.S.D.A NRCS, 1997). Therefore, where buffers occur in coarse-textured, glaciofluvial deposits (*i.e.* highly permeable sand and gravel deposits) that contain significant sand and gravel aquifers, wider buffers should be required.

5.4 Hydrology/Position in the Watershed

- **Stream order**/position in the watershed (small order streams occupying an upper position in the watershed are typically more sensitive to land use impacts than are higher order streams and should not be afforded narrower optimal buffer widths because of their small size),

- The presence or absence of tributary streams or other **surface water features** within the buffer having a hydrologic connection to the receiving stream (buffers containing surface water features that discharge runoff to the stream have wider optimal buffer widths),

- The presence or absence of **groundwater discharge** (*e.g.*, springs) in the buffer (buffers associated with groundwater discharge to the stream have wider buffers for optimal function).

- The presence or absence of **wetlands** within the buffer (wetlands provide important water quality and quantity functions and riparian wetlands are typically connected by surface or subsurface hydrology to streams; disturbance to wetland soils can compromise wetland function and wetlands in and adjacent to buffer should be preserved for optimal buffer function).

- **Floodplains** (floodplains, no matter how wide, should be entirely encompassed within the recommended buffer width. Preferably, floodplains should be considered part of the in-stream resource itself, and the buffer width measurement should begin at the landward edge of floodplains. The rationale is that streams meander over time and could potentially occupy any part of the floodplain in the future. In addition, floodplains accommodate streamflow during flood periods and can be considered to literally be a part of the stream itself).

Optimal buffer width should not be lessened for first order streams no matter how narrow since early life stage rearing habitat is concentrated in smaller headwater stream reaches that are often more sensitive to water quality and quantity impacts (Davies and Sowles, 1984; Murphy, 1995; Chesapeake Bay Program, 1995; Kahl, 1996). In most cases, smaller streams are afforded less regulatory protection than are larger streams. For many functions, such as the provision of wildlife corridors and wildlife habitat, this makes sense. However, smaller headwater streams are typically more vulnerable to water quality and quantity impacts as they are less able to dilute or buffer impacts such as sedimentation, solar heating, nutrient loading, or base flow alterations (*e.g.* water withdrawal). As such, riparian buffers adjacent to critical salmon habitat in first and second order streams should be afforded the same optimal riparian buffer widths as larger streams.

Where surface water features are present in the buffer that have a hydrologic connection to the receiving stream, the optimal buffer width would be larger since these features can allow contaminants to quickly bypass the root zone of the riparian buffer (Adamik et al., 1987; Ohio EPA, 1994; Murphy, 1995; Chesapeake Bay Program, 1997). Such surface water features include intermittent streams, perennial streams, ditches and gullies. The presence of surface water features provides increased potential for “leaky” or ineffective buffers since they provide a potential concentrated flow path whereby sediments, dissolved nutrients and other potential pollutants can effectively bypass the buffer. Conversely, diffuse flows (*e.g.* sheetflows) through a buffer encourage infiltration and energy dissipation, allowing sediments and nutrients to be trapped. Surface water features surrounded by forested buffer are more effective at trapping sediments and pollutants to the extent that coarse woody debris inputs increase channel roughness, deflect flows to the adjacent forest and reduce channel incision. In addition, there is a direct relationship between the width of forested buffer that the surface water feature flows through and the degree of shading and temperature regulation.

Springs may provide particularly important hydrologic inputs to receiving streams, functioning to maintain base flow inputs during the summer months. Groundwater seepage from the buffer can also help to cool stream temperatures in the summer and moderate stream temperatures in the winter (Correll, 1997; Speirman et al., 1997).

Many riparian wetlands have important surface and sub-surface hydrology connections to the stream during at least a part of the year. Wetlands provide important water quality functions. Wetlands are more effective than uplands for example at converting potentially available nitrogen to a gaseous form through denitrification. Buffers containing wetlands (especially those wetlands connected to the stream by surface drainage, including intermittent or seasonal drainage) will be more effective to the extent that the wetlands within them are able to function at optimal levels (Chase, 1995; Correll, 1997). Any surface water connection between the wetland and the stream increases the potential risk of sedimentation related to inadequate buffer width.

Floodplains, no matter how wide, should be entirely encompassed within the recommended buffer width and, ideally should be buffered themselves). Streams meander over time and could potentially occupy any part of the floodplain in the future. Floodplains are also of vital importance in terms of accommodating and attenuating overbank flows and perform the same water quality functions as wetlands.

6.0 BUFFER WIDTHS

KA conducted a review of the available literature to identify specific buffer widths necessary for the protection of critical salmon habitat and the maintenance of the specific buffer functions that investigators identify as being important for various aspects of the salmon life cycle. The issue of buffer width is organized below according to the specific buffer function being maintained.

6.1 Shading and Temperature Regulation

References indicate that the ability of a forested buffer to provide shade is proportional to tree height. Suggested forested buffer widths necessary to maintain adequate temperature regulation function for cold water fisheries are listed below. There is a good science-base to support maintaining a no harvest zone (mature forest canopy) within a zone equivalent to about 0.5 to 1.0 mature tree heights for larger streams and 15-25’ for 1st order streams. Therefore, a 35’ wide the no-harvest zone (Zone 1) was determined as optimal for the shading function as applied to salmon streams of all sizes in eastern Maine, where typical mature tree heights are approximately 40’-75’. Since Zone 2 prescribed land uses for this method require that a large portion of the trees remain, partial shading is also accomplished from trees in Zone 2. References listed below indicate that although forested widths as great as 80’ or more can be necessary to achieve 100% of potential shading, the majority of shading occurs at a width of about 0.5 to 0.75 mature tree heights.

Reference	**Suggested Buffer Width (forest canopy closure maintained)**
Chesapeake Bay Program, 1997	15-25’ for small streams; although as high as 50-75’ for trout depending on stream size, tree heights and slope. points out that shading is important for small stream orders (although it takes narrower buffer width to provide adequate shading for small streams) and exponentially less important for large streams. draws conclusions from available literature
Murphy, 1995	20-80’; the width needed to attenuate solar radiation impacts is generally less than 1 tree height
Chase et al., 1995 (revised 1997)	49-80’; summarizes research of others to get range

Reference	Suggested Buffer Width (forest canopy closure maintained)
Welsch, 1991	15’ no harvest; 15-60’ periodic harvesting of trees but not other land uses (*e.g.* no impervious surfaces or agriculture)
FEMAT, 1993	cumulative effectiveness for shading approaches 100% at a width of about 0.75 tree heights form stream
Hewlett and Fortson, 1982	25-50’ in hilly terrain; summarizes research of others to get range
Spence, 1996	summarizes research of others to get wide range from less than 1 tree height to as high as 170’
US ACOE, 1991	33’-66’; summarizing work of others. 33’ for mountain stream in New Hampshire

6.2 Streamflow Regulation

There is no consensus on specific buffer widths required to maintain base flows and attenuate peak flows. This function is typically attributed to watershed scale landscape characteristics and land uses rather than to just the immediate buffer (Murphy, 1995). Therefore, although it is generally accepted that naturally vegetated buffers play an important role in maintaining natural flow regimes, it is not possible to assign specific suggested buffer widths. Maintaining optimal buffer widths for other buffer functions (*e.g.* shading and temperature regulation, water quality protection, etc..) will promote base flow maintenance and peak flow attenuation as well.

6.3 Water Quality Protection

For buffers to adequately protect receiving streams from water quality degradation not related to shading or temperature regulation, it is not necessary to maintain canopy closure or even a forested system. Optimal buffer widths for water quality functions, such as sediment and contaminant removal, are wider than for the other buffer functions relevant to salmon habitat protection. The range of optimal buffer widths for the method to protect critical salmon habitat is from 70’ to more than 300’ depending on buffer characteristics. This range is consistent with some of the more conservative widths suggested in the literature.

Reference	Suggested Buffer Width (vegetated but not necessarily forested)
Chesapeake Bay Program, 1997	draws conclusions from available literature 45' for pesticide reduction 50-100' for sediment and phosphorous removal 35-90' for nitrogen removal
Murphy, 1995	26-200' for sediment removal from forestry operations
Chase et al., 1995 (revised 1997)	25-375'; summarizes research of others to get range
Welsch, 1991	95' with controlled uses beginning at 15'; managed forest in 15-95' zone serves to remove nutrients sequestered in wood, haying or controlled grazing possible in 75-95' zone
Budd et al, 1987	98' adequate to protect aquatic insects from sedimentation. draws conclusion from work of others
Spence, 1996	98-295' for sediment control wide range for nutrient retention depending on land use and buffer characteristics summarizes research of others to get range
US ACOE, 1991	Summarizes the work of others to get wide range for sediment and nutrient retention in riparian forests adjacent to various land uses; reports studies noting most water quality renovation occurring in the 63' closest to the stream.
Ohio EPA, 1994	Summarizes the work of others to get range of 35' to 230' for water quality (as well as organic inputs and riparian wildlife habitat), with one outlier (1 source out of 21 total) at 300' for buffering septic nutrients
Vermont Fish and Wildlife Department, undated	Suggests a range between 25' and 110' for general purpose stream protection, with increasing buffer width for increasing slopes

6.4 Forest Organic Matter Inputs

The literature indicates that effective buffer widths for this function are the same or less as for shading and temperature regulation, or generally at a width less than 0.75

mature tree heights. Murphy (1995) indicates that the vast majority of all organic debris inputs to in-stream areas comes from the area within 10 m (about 33') from the stream edge.

Key References for determining optimal buffer widths for a range of functions :

Hewlett and Fortson, 1982; Bryant, 1983; Phillips, 1989a and 1989b; Davies and Sowles, 1984; Lisle, 1986; US ACOE, 1991; Welsch, 1991; Ohio EPA, 1994; Chesapeake Bay Program, 1995; Murphy, 1995; Chase et al., 1995 (revised 1997); (Spence et al., 1996; Moring and Finlayson, 1996; Mitchell, 1996; Kahl, 1996; Kahl, 1996; Chesapeake Bay Program, 1997; USDA Forest Service, 1998 (in press))

7.0 FIXED MINIMUM VERSUS VARIABLE WIDTH BUFFERS

Variable width approaches, unlike fixed width approaches, can be designed to take into account the relationship between site-specific conditions and desired buffer functions. Fixed-width buffers are much more widely applied and easier to implement (Chase et al., 1995). Variable-width buffers are better able to protect desired buffer functions in a customized manner and are flexible with regard to site-specific physical buffer conditions. The concept of applying multi-zone, variable-width buffers around target resource protection areas has precedent. For example, the report entitled "Evaluation and Recommendations Concerning Buffer Zones Around Public Water Supply Reservoirs" prepared by the New Jersey Department of Environmental Protection (1989) concludes that a zoned multi-width approach to buffer protection is preferable to simple, fixed-width buffers for effective protection of the resource where land use pressures must also be considered. The paper entitled "Forested Riparian Buffers: Practices and Laws in the Chesapeake Bay States" presented at the workshop entitled "Buffering Wetlands and Watercourses from Human Encroachment" (1994) also summarizes state programs where variable buffer widths for different buffer conditions have been implemented.

Perhaps the most widely known and accepted version of the multi-zone, variable-width buffer concept has been developed by the USDA Forest Service (Welsch, 1991, USDA FS, 1997, USDA FS, 1998). This multi-zone riparian management concept, which has recently been referred to as the “Forest Service Standard”, specifies standards for each zone for purposes of maintaining various riparian water quality functions in the Chesapeake Bay Watershed and uses three zones (USDA FS, 1998). Zone 1, closest to the stream, is a no harvest zone which should remain undisturbed. The width specified for this application was 15’. Zone 2, between 15’ and 75’ calls for periodic tree removal using Best Management Practices (BMP’s) to remove pollutants and nutrients sequestered in tree boles and branches. It does not allow for land uses, such as livestock grazing, row crops, or development (*i.e.* impervious surfaces) which could alter the water quality maintenance function of this zone or alter runoff patterns or quantity. Zone 3, is of variable width (at least 20’) and is intended to provide certain water quality functions such as sediment filtering. This zone allows for uses such as haying operations or controlled grazing that make use of grasses or forbs which are periodically removed along with the nutrients and pollutants sequestered in the plant material.

This method to protect Atlantic salmon habitat uses two zones. As previously discussed a 35’ no disturbance zone, closest to the stream, is recommended for Zone 1. This zone is set at 35’ rather than 15’ (as with the Forest Service Standard) since the intended purpose is to protect Atlantic Salmon habitat and water temperature and organic debris input functions are critical factors with respect to salmon habitat. The primary functions of Zone 1 for salmon habitat conservation is to provide optimal shading and temperature regulation, provide organic detritus and woody debris inputs, and to function as a final barrier to potential water quality degradation. Zone 2 varies from as narrow as 35’ to as wide as 300’ or more and provides several important primary functions including protecting Zone 1 from potential wide-scale wind impacts, and providing water quality polishing.

Standard fixed width riparian buffers are typical in the context of regulatory programs throughout the country. One of the most common all purpose, fixed-width regulated setbacks for non-exempted land uses adjacent to watercourses in the eastern U.S. is 100’ (Chase et al., 1995; Todd, 1998). Chase et al. (1995), after reviewing available literature and consulting with natural resource professionals and regulators, determined that 100’ was the most reasonable width if a standard fixed-width riparian buffer was to be chosen to protect New Hampshire’s streams and rivers. Chase et al. (1995) discuss that limited timber removal within the buffer can benefit buffer functions, but that complete forest removal can result in permanent negative impacts to buffer function. This reference includes timber removal that adheres to BMP’s for erosion control and timber harvesting operations as a legitimate component of buffer management.

8.0 RATIONALE FOR ZONE 2 LAND USE SPECIFICATIONS

Northern New England forested systems are relatively resistant to erosion and sedimentation losses including losses of phosphorous adsorbed to soil particles as long as there is only minimal disturbance to the forest floor (Bormann et al., 1974; Chase et al., 1995; Kahl 1996). Kahl (1996) concludes that harvesting operations often result in substantial soil disturbance related to a combination of inadequate BMP's and windthrows that expose mineral soils in situations where cutting has compromised wind-firm conditions. The forestry specifications advocated in this method are designed to address this potential for soil disturbance related to forestry operations by prescribing measures which both minimize the potential for soil disturbance related to harvesting methods, and maintain wind-firm conditions by prescribing limits to harvesting.

9.0 DISCUSSION

There is a great deal of scientific literature to indicate the relationship between various buffer characteristics and buffer effectiveness. Much of this literature indicates specific buffer widths necessary to maintain buffer effectiveness for either a single function or for a suite of functions. Studies to determine adequate buffer width have been conducted for a wide range of geographic areas and ecological conditions, and for a wide range of applications. Although there is not a large literature base indicating buffer widths required specifically to protect Atlantic salmon habitat in downeast Maine given various buffer conditions, studies from other locations and for other purposes serve as a good basis for estimating optimal widths for this purpose.

The range of optimal recommended buffer widths generated by the Method to Determine Optimal Riparian Buffer Width for Atlantic Salmon Habitat Protection is from 70' to more than 300'. The method has attempted to generate recommended buffer widths for specific buffer conditions that will ensure protection of important salmon habitat. Maintaining optimal riparian buffer widths will also preserve the ecological integrity of the stream for non-target biota. Recommended buffer widths for this method are generally within the range of recommended buffer widths for other applications found in the literature, which was determined to be generally between 25' and 450'. Note that the larger recommended widths found in the literature are generally for the wildlife corridor buffer function (Chesapeake Bay Program, 1997), which was not of primary concern in the development of this method.

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